Investigating the burden of parasitic zoonotic diseases

Torgerson, P R ; Craig, P

Abstract: Although the global burden for most parasitic zoonoses is not yet known, it is clear that collectively parasitic zoonoses have a similar human disease burden to any one of the big three human infectious diseases: malaria, tuberculosis or HIV. In addition many also have a substantial animal health and economic burden.

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The Control of Neglected Zoonotic Diseases

Community-based interventions for prevention and control

Report of the third conference organized with ICONZ, DFID-RIU, Gates Foundation, SOS, EU, TDR and FAO with the participation of ILRI and OIE

WHO headquarters, Geneva, Switzerland
23–24 November 2010

World Health Organization

© P. Craig, Salford, UK.: "Yaks and dogs in Tuanjie village, Shiqu County, Ganze Tibetan Autonomous Prefecture, Sichuan Province, China". [A highly endemic area for human echinococcosis].

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Preface

It is now five years since the World Health Organization (WHO), with the United Kingdom's Department for International Development (DFID) Animal Health Programme, launched the first international meeting to consider how to tackle a group of ancient, endemic and largely forgotten zoonotic diseases. During the course of that meeting – which brought together some 50 researchers, public health practitioners and members of international organizations from the Americas, Africa and Asia – we realized that these diseases, although different in causation, incidence and impact, had much in common. Woefully under-diagnosed, affecting mainly poor people in remote rural or marginalised urban and peri-urban communities, usually in low income countries, these are diseases of poverty. By undermining human health at the same time as affecting livestock, they impose a dual burden on poor communities.

In 2007, we met again at the International Livestock Research Institute (ILRI) under the aegis of WHO and its partners, this time as a much larger group focused on Africa and policy issues. Resource constraints and competing human and animal health priorities have meant that these diseases are often simply forgotten in Africa.

Out of these meetings came a recognition that control of this group of grossly neglected diseases is often impeded by the fact that it depends crucially on mobilising both the medical and the veterinary sectors. WHO now recognizes these diseases as neglected zoonotic diseases (NZDs). Since 2008, NZDs have been an integral part of WHO's Department of Control of Neglected Tropical Diseases and feature in its Global Plan to Combat Neglected Tropical Diseases 2008–2015. Priority NZDs were also included in the first WHO report on neglected tropical diseases: "Working to overcome the global impact of neglected tropical diseases" (WHO, 2010).

This third NZDs meeting, brought together an even larger and more diverse group than before. More than 100 participants from Africa, the Middle East, the Americas, Asia and Australia, including policy-makers, international organizations, researchers and field workers directly involved in disease control attended the meeting, as well as a range of observers including a number of young researchers representing the next generation of NZD specialists sponsored by the European Union.

In this report we have tried to present the various issues, problems and challenges that were discussed against the backdrop of the many inspiring control programmes that were presented. Again and again these programmes demonstrated how the NZDs are not so much re-emerging as rediscovered – once a concerted effort is made to find and treat patients – and how both control and prevention rely on involving and inspiring the animal keeping communities where they prevail.

The representatives of WHO, DFID-RiU, ICONZ, EU, SOS, TDR and FAO

Acknowledgements

The third meeting on neglected zoonotic diseases (NZD3) was organized by François Meslin with Ian Maudlin, Sue Welburn, Isabel Minguez-Tudela, Mark Eisler, Lee Willingham, Deborah Kioy and Katinka de Balogh. It would not have been possible without the technical and/or financial support of many partners, to whom we are grateful. These include the European Union Framework 7 Project Integrated Control of Neglected Zoonoses in Africa (ICONZ), the UK Department for International Development's Research into Use Programme (DFID-RiU), the Bill & Melinda Gates Foundation (BMGF), the Research Directorate of the European Commission, the Stamp Out Sleeping Sickness Project (SOS, University of Edinburgh), the UNDP/UNICEF/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR), the Food and Agriculture Organization of the United Nations (FAO), the International Livestock Research Institute (ILRI) and the World Organization for Animal Health (OIE).

We are grateful to our Chairman, Samson Mukaratirwa, for coordinating our discussions, keeping us to time and providing his valuable insights into the debates; and to our keynote speakers, David Molyneux and Alexandra Shaw who were able to strike just the right note to set the scene for this meeting. Particular thanks are due to Wendy Harrison and Eric Fèvre, our rapporteurs, whose summing up underpinned a lively discussion at the end of the meeting and whose meticulous notes have helped greatly in putting together this report, which was undertaken by Alexandra Shaw. We much appreciated the feedback and comments received from those who made presentations at the meeting, in particular from David Molyneux. We also thank Beatrice Wamutitu for handling the meeting's administrative aspects and acting as our link person during its planning.

Lastly, we would like to thank everyone who attended, contributing their presentations, comments and materials, which led to an extremely informative, lively and productive meeting.

Dedication

As this report was being prepared, we learnt with great sadness of the passing away of Isabel Minguez-Tudela on Saturday 16 April, 2011. Despite her illness, Isabel was determined to attend this third NZD meeting, having been a staunch advocate of work on these diseases for many years.

Isabel attended the first WHO NZD meeting in 2005 and her enthusiasm and institutional support were a major motivating factor in the setting up of the subsequent two meetings. Many of those working in this field have benefitted from her encouragement and support.

She was born in Spain in 1956. She studied as a veterinarian and her PhD provided important new insights into African Swine Fever. She initially worked as a veterinary inspector for the Spanish border control agency. In 1990 she joined the European Commission. In 1996 she became senior scientific officer at the Directorate General for Research and Innovation. Since then she commissioned and managed a large portfolio of animal health research projects. In her presentation at our meeting, she described with passion several important EU projects on neglected zoonoses research that she was currently involved with. Isabel has left behind an important legacy of progress in the field of animal health research and strong networks among veterinary scientists. She played a vital role in raising the international profile of the neglected zoonotic diseases.

Isabel was also paying special attention to the next generation of zoonoses researchers and control officers. To that goal she worked very hard in October 2011, in spite of her ill health, to ensure the participation at this meeting of no fewer than 29 mostly young professionals from East African and European countries.

She will be remembered for her total dedication to zoonoses research and control, a strong determination to move the subject always a step further and her unfailing kindness. For many of us, our ongoing work in this field will be inspired by her.

In memory of the encouragement, inspiration and kindness she showed to so many of us and of all she has done to promote the cause of those suffering from, and at risk of contracting NZDs, we dedicate this report to her.

François Meslin

Summary

On the positive side: the past five years have seen a growing interest in these diseases, their recognition by WHO as neglected zoonotic diseases, and the launching or continuation of many successful control programmes.

Four main themes emerged from this meeting.

First, under-diagnosis and misdiagnosis are more important issues than previously thought. They are crucial to understanding why this cluster of diseases is so chronically neglected. Talk after talk highlighted how it is only once investigations start that patients are found. Typically, these patients have been treated for another condition, notably malaria, often several times. Many NZDs involve severe disability; several are fatal if left untreated. Published case histories are necessarily those of people who were diagnosed – the others simply silently suffer an untold burden of human misery and ultimately death. The cost of misdiagnosis is not only that of untreated patients but also of the household and public sector resources wasted and misallocated to the wrong diagnosis. Thus the need to improve diagnostic capacity – by reinforcing both human clinical skills and by supplying appropriate and accurate tests – has become urgent.

Second, community engagement and hence empowerment is a crucial if success is to be achieved. Because these are diseases of poverty, occurring in remote or marginalised communities, the people affected are burdened with the many vital activities necessary for survival on a day to day basis. Despite this, once people recognise the significance of these diseases, communities can be mobilised to tackle sanitation issues, bring their roaming dogs forward for vaccination, consider boiling their milk – simple but effective examples which contribute to reducing the burden of NZDs.

On the negative side: as more work has been done on the incidence and impact of these diseases we have come to realise that they are more widespread than we thought, cause more ill health in humans and more losses in livestock – and remain desperately under-funded.

Third, because NZDs are transmitted to people from animals, controlling animal reservoirs can be cheap and effective compared with the costs of providing care for patients. However, this requires concerted action and communication between the veterinary and medical sectors. The higher profile that these diseases have now achieved has led to greater awareness among both sectors, but more resources are needed to translate this awareness into action.

Finally, although further public sector involvement is recommended, since zoonoses control is a global public good, underfunding must be tackled by all means possible. Public-private partnerships have much to offer in this context. There is already an impressive track record of drug donations, but the private sector can also help fund novel routes for delivery, especially in combating the animal reservoir by tackling livestock health and engaging with livestock keepers. Unlocking donor funding will depend on successful advocacy, backed up by better information on the true burden of these diseases.

At the end of the meeting a comprehensive statement – developing a roadmap for NZD prevention and control – was produced.

At the end of the meeting the participants drafted a comprehensive statement. This brought together the strands from the various discussion and presentations. The statement acknowledges the achievements made since 2005, notes the many constraints and problems that have to be faced when dealing with these diseases and makes recommendations towards a road map for NZD control in the future.

Contents

1 Neglected zoonotic diseases: the "poor cousins of the poor cousins"

Only 0.6% of international global assistance for health is devoted to the control of Neglected Tropical Diseases. The Neglected Zoonotic Diseases (NZDs) probably have a share of less than 10% of that: 0.06% of the total.

David Molyneux

The world is familiar with the global threats of zoonotic viral infections, which bring fear to populations in both developed and developing countries. The outbreaks of BSE (bovine spongiform encephalopathy) and SARS (severe acute respiratory syndrome) and of influenza pandemics capable of crossing the species barrier, are estimated to have cost the global economy at least US$ 200 billion. Such zoonoses contrast in many ways with the endemic zoonoses to which the poorest livestock-dependent populations are exposed. However, pandemic threats can be predicted to emerge frequently and unpredictably from human contact with animals. Rapid response becomes a prerequisite for governments, United Nations agencies, regulatory authorities and the pharmaceutical industry, for coordination, virus surveillance and vaccine production – a demand originating primarily from the developed world aimed at protecting its populations.

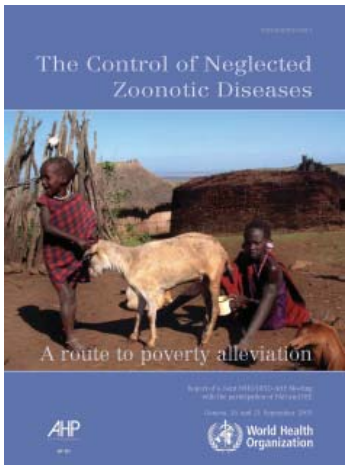
However, the poorest people, defined as those who live on less than US$ 2 per day, are often overlooked when pandemic threats emerge. They are the ones subjected to the daily burden of zoonoses, as are their animals on which they are often totally dependent for cash, animal protein and as core assets. No effective government services are available to support these people's needs, since they are generally not perceived to contribute significantly to the national and global economy. Their governments have few resources to allocate to their health as the health systems of poor countries function on only a fraction of those of developed economies. Until recently, the developed nations' view of the diseases of the developing world was that there are only a limited number of communicable diseases of importance. This stemmed from the power of advocacy constituencies and also because these diseases were killing, or had the potential to kill, large numbers of people annually. Research and control of these diseases receive a large majority of the total amount of funding as compared with the many other infections that kill, blind, deform and disable many more – the "bottom billion" – those who have few resources to access or afford "health care."

Thus, either within the Millennium Development Goals (MDGs) or when set against the "rapid response / early detection" agenda which has come to dominate many activities carried out at the animal–human interface, the neglected zoonotic diseases (NZDs) are simply left behind. In the context of the MDG 6, neglected tropical diseases (NTDs) fall into the category "other diseases", currently a convenient catch-all basket for policy-makers. Within this group, NZDs form a small subgroup that receives less attention and fewer resources. Just as the NTDs are the "poor cousins" of health aid, the NZDs have become the even poorer "poor cousins of the poor cousins".

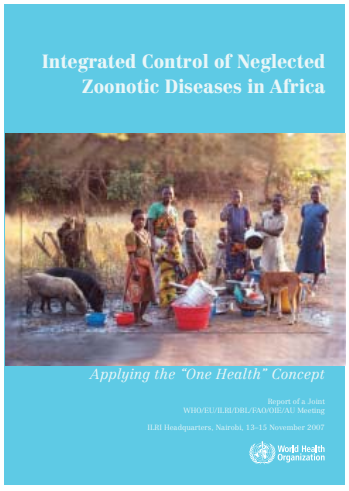
To reverse this neglect, there are three priorities which need to be addressed:

- assessing the burden of zoonoses needs to go beyond DALYs (disability-adjusted life-years) to take into account their **dual burden on the health of humans and of livestock** and thus their total cost to society;
- assessing the **cost effectiveness of community health care delivery methods** for the control of zoonoses;
- **promoting intersectoral collaboration** (health, livestock, agriculture, natural resources and wildlife), cross systems policy and prioritization.

2 Five years on – taking stock



Proceedings of the WHO/DFID-AHP meeting "The control of neglected zoonotic diseases: a route to poverty alleviation".



Integrated control of Neglected Zoonotic Diseases in Africa: "Applying the One health concept".

In September 2005, researchers, policy-makers and people involved in disease control met at WHO's headquarters in Geneva, Switzerland, to consider a selection of endemic zoonoses closely associated with poverty. The group identified these as a subset of diseases with a significant cumulative health and economic burden which was not being addressed properly. Out of that first meeting, NZD1, came the concept of neglected zoonoses. A second meeting, NZD2, was held in Nairobi, Kenya, in November 2007, with a focus on Africa and on policy makers. Its theme was applying the "One Health" concept to achieve integrated control.

In the five years since the first meeting, the concept of NZDs has been widely accepted and the NZDs platform is now well embedded within the NTD Department of WHO. During this period progress has been made in a number of fields.

- The **burden of these diseases** is becoming better known. There are now global estimates of DALYs (disability-adjusted life years, which measure the burden of ill health in people) for echinococcosis, zoonotic leishmaniasis, trypanosomiasis and rabies. These take into account estimates of under-reporting. Studies of the economic burden in livestock in some areas, or for particular outbreaks, exist for some diseases, notably cysticercosis, cystic echinococcosis and Rift Valley fever. Work on assessing the burden of bovine tuberculosis, brucellosis, cysticercosis, foodborne trematode infections, toxoplamosis and zoonotic schistosomiasis is in progress.
- Subregional, regional and global disease-specific **networks** and public–private **partnerships** have been established, facilitating the control of diseases such as fascioliasis and zoonotic trypanosomiasis.
- Much work has been done on collating information based on which **global situation analyses** have been undertaken and research priorities identified.
- A number of **field projects** to control and study diseases as well as **research and development projects** have been undertaken, supported by major funding bodies including, among others, DFID, RiU, the European Commission, the Bill & Melinda Gates Foundation, the Wellcome Trust, the NIH Ecology of Infectious Diseases Program, VLIR and DANIDA.
- For the first time, target dates have been set for **eliminating human and dog rabies** in Latin America (by 2015) and ASEAN (Association of South East Asian Nations) countries (by 2020).

3 What are neglected zoonotic diseases?

A 'tick' list for defining an NZD. A NZD is:

- ✓ *a zoonosis*
- ✓ *an ancient disease*
- ✓ *a disease which imposes a dual burden on human and animal health*

which is distinguished from more high profile zoonotic diseases because it:

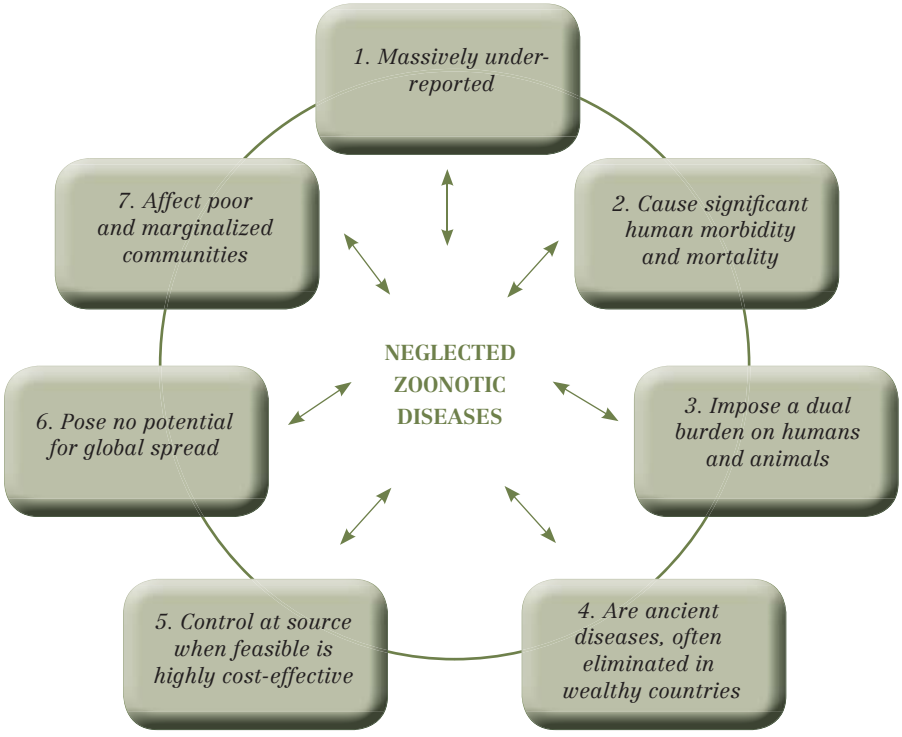
- ✓ *affects mostly poor and underserved populations*
- ✓ *is under-diagnosed and under-reported*
- ✓ *does not travel far and cross distant boundaries*
- ✓ *generates significant health burden and economic losses*
- ✓ *control at source when feasible is cost effective*

These last five characteristics are shared with the other Neglected Tropical Diseases (NTDs).

Lorenzo Savioli

he concept of "neglected" zoonotic diseases emerged from a meeting held at WHO's Geneva headquarters in September 2005. The meeting's focus was the ancient endemic zoonoses that have largely been controlled in North America and Europe and which have tended to be forgotten or overlooked as interest in these regions has shifted to newly emerging zoonoses which have the potential for pandemic spread. During the course of this meeting, it became clear that the endemic zoonoses have a number of common characteristics. These distinguish them from the emerging zoonoses with the capacity for rapid global spread – such as avian influenza and from the foodborne zoonoses – associated with intensive farming and the global trade in food products – that are of economic and health significance worldwide and are not confined to poorer communities.

- NZDs are **ancient diseases** that have been known since historical times. In many rich countries they have long been successfully **controlled or even eliminated**. They are not new pathogens, nor have they recently crossed from affecting animal populations to affecting humans.
- Their transmission depends on **long established relationships and interactions between people and domestic animals or nearby wildlife reservoirs**. These relationships persist in many parts of the world, although in some more affluent environments, where animals are more isolated from people or animal husbandry has become more intensive and controlled, conditions no longer facilitate transmission between animals and people to the same extent.
- These are mostly endemic diseases; although they can move with their animal reservoir, they mostly **do not spread rapidly** on a global scale and are often confined by ecological boundaries.
- These are **serious illnesses** that often cause permanent **disability** and, for several diseases if not dealt with early or appropriately, are inevitably **fatal**.



Programmes to control diseases like brucellosis were launched in Europe decades ago. Maltese stamp commemorating the 1964 anti-brucellosis congress.

- **Cures exist** for these diseases – and where patients are found in the early stages of the disease, treatment is often **relatively inexpensive** and successful.
- **Control** of these diseases is usually possible. Often control is best undertaken via the domestic animal reservoir. For some diseases, **control at this level is highly cost effective**. Control and elimination, however, may require other interventions in humans (using preventive chemotherapy or case management), increased public awareness to reduce contacts between humans and animals and/or modification of the environment to eliminate populations of intermediate or definitive hosts. Some of these diseases rank among the cheapest to control in terms of their benefit to human health.
- NZDs are, above all, **diseases of poverty**. They affect poor and marginalized people in poorer countries who live in close contact with animals, often in unsanitary conditions, where coverage by health services is already inadequate.
- These diseases tend to be overlooked by clinicians as well as policy-makers and are hence **under-diagnosed** and hence **under-reported**. They often share clinical features, particularly fevers, with other more common diseases or require complex diagnostic tests to confirm their presence.
- There is often a general **lack of responsibility** for zoonotic diseases at provincial, national and regional levels, and a subsequent **failure to prioritize their control** by human and animal health sectors.
- Because of under-reporting or lack of public or international interest, the **global burden** of individual NZDs in terms of DALYs is often either an **underestimate, or has never been appropriately calculated**.

Finally, one or more of these diseases is found in most poor communities where livestock are kept, **affecting the health and productivity of livestock** by causing infertility, death, low milk yields and rendering meat inedible. Thus they impose a **dual burden on human and animal health** in the very households and populations least able to cope with such problems

4 Neglected zoonotic diseases: an open-ended list

Neglected zoonotic diseases have been an integral part of WHO's Department of Control of Neglected Tropical Diseases since 1 August 2008.

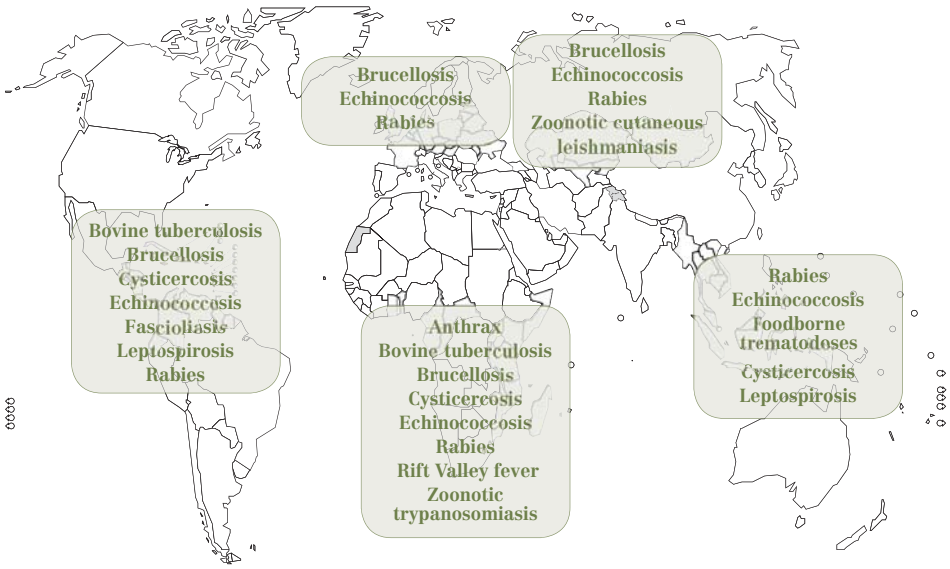
Control of neglected zoonotic diseases is part of the Global Plan to combat neglected tropical diseases, 2008–2015

Lorenzo Savioli

In 2005, the first international meeting on neglected zoonoses considered seven endemic zoonoses: anthrax, bovine tuberculosis, brucellosis, *T. Solium* cysticercosis/taeniosis, cystic echinococcosis/hydatidosis,human and dog rabies and zoonotic human African trypanosomiasis. Since then, as international awareness of these conditions has increased and a clearer idea of their characteristics has emerged, the list has grown. The map below shows the diseases identified as major NZDs by WHO region. These diseases are most widespread among poorer populations, but while some are geographically restricted others are found in all six WHO regions. As evidenced for the African Region, these diseases often overlap *at country level*. More than 30% of African countries have three or more of the five following NZDs (cutaneous leishmaniasis, zoonotic trypanosomiasis, echinococcosis, porcine cysticercosis and dog rabies) in various combinations.

The list is not exhaustive and it remains open-ended. For example, over the past few years, *Streptococcus suis* has emerged as a significant zoonotic disease mostly affecting poor pig farmers in China and other countries of the South-East Asia Region. Although not initially considered an NZD, an epidemic-prone vector-borne zoonosis like Rift Valley fever could be considered part of the list because it causes major impacts on the health and livelihoods of small livestock producers in the Horn of Africa. Fish-borne liver fluke infections, and the associated negative health impacts, including carcinogenic effects, are also important emerging public health problems in East and Southeast Asia. There is growing evidence that the zoonotic form of schistosomiasis, caused by *Schistosoma japonicum*, and found in China, Indonesia and the Philippines, poses a substantial burden on human health. As information accumulates about the common health problems of humans and animals inhabiting marginalized livestock-keeping communities, the list of the zoonoses meeting the criteria of NZDs may grow. However, operationalizing the NZDs concept may require a shorter list of NZDs targeted for control and possible elimination in certain geographical and epidemiological settings.

Of the 12 diseases described in detail below, 6 are either inevitably fatal or have serious forms that lead to death if left untreated.



A brief description of each disease follows.

Alveolar echinococcosis(AE) or multilocular echinococcosis

Alveolar echinococcosis, or multilocular echinococcosis, is caused by the tapeworm *Echinococcosis multilocularis*. The natural definitive hosts are foxes, chiefly the red fox and arctic fox. The intermediate hosts are wild rodents infected by ingestion of the eggs spread in the faeces of infected foxes. Domestic dogs and cats may also serve as definitive hosts by ingesting infected wild rodents. Humans can become infected when handling dead foxes or eating uncooked wild plants contaminated with infected foxes faeces. Alveolar echinococcosis can have serious consequences for human health. Parasitic infiltrative tumour-like lesions can be formed in the liver, lungs and brain and if untreated, the outcome is fatal.

The distribution of *E. multilocularis* is limited to the northern hemisphere. In north America, the parasite is present in subarctic regions of Alaska and Canada and in a few northern states of the United States. In Europe it is spreading in central, eastern and western countries and is endemic in the central Asian republics, Afghanistan, Turkey, the Islamic Republic of Iran, the Russian Federation, northern Japan, western China and northern United States and Canada. A systematic review on the burden of alveolar echinococcosis commissioned by WHO indicated that greater than 90% of the global burden of this disease is occurring in China.

Anthrax

Anthrax is primarily a disease of herbivores, although all warm-blooded species are susceptible to an extent. The causative agent is the spore-forming bacterium *Bacillus anthracis*. The disease reservoir is soil contaminated by spores in the recent past or possibly several decades ago. Humans normally acquire anthrax either by direct or indirect contact with infected animals or through occupational exposure to contaminated animal products. About two-thirds of reported cases occur in developing countries. In animals, the disease is almost always rapidly fatal. In humans, the disease takes three forms. Inhalation anthrax is an occupational disease reported only in industrialised countries and acquired by breathing in spores; gastro-intestinal anthrax is acquired from eating infected meat from an animal that died of the disease and the cutaneous form, which accounts for more than 95% of reported cases in developing countries, is acquired through skin lesions. Although in the West the disease incites fear because of its bioterrorist potential, its role in causing illness in poor livestock-keeping communities and sudden deaths in their herds and flocks is largely ignored.

Bovine tuberculosis

In humans, the vast majority of cases of tuberculosis are caused by *Mycobacterium tuberculosis*. However, humans may be infected by a number of other tuberculous (TB) bacteria, of which *M. bovis*, causing so-called bovine tuberculosis, is one of the more prevalent and has the widest host range of all such bacteria. Tuberculosis caused by *M. bovis* often occupies sites other than the lungs (extra-pulmonary), but in many cases is clinically indistinguishable from *M. tuberculosis* infection. However, patients with *M. bovis* infection frequently fail to respond to the commonly used anti-tuberculosis medicines, sometimes resulting in fatalities. Alternative and more expensive medicines are often needed to treat patients, increasing the burden on health services. Little is known about the proportion *M. bovis* contributes to the global tuberculosis epidemic, but sporadic cases are reported from many African and Asian countries; work undertaken in the United Republic of Tanzania indicates that this may be a substantial fraction. Bovine tuberculosis appears to be increasing at a similar rate to the total number of cases of TB, so that it shares

in the HIV/AIDS-linked pandemic. In livestock, particularly cattle, the disease causes lowered productivity, but seldom death. Like brucellosis, bovine TB has been largely eliminated from herds in the developed world by a test and cull programme.

Brucellosis

Brucellosis, one of the world's most widespread zoonoses, is caused by bacteria of the genus *Brucella* that primarily affect cattle, sheep, goats and pigs, causing abortion, followed by permanently reduced fertility and chronically lowered milk yields in affected animals. The infection can be transmitted to humans via direct contact with livestock or through drinking unpasteurised milk from an infected animal. Symptoms of human infection include recurrent bouts of high temperature – hence its other name, "undulant fever" – and its tendency to be misdiagnosed as drug-resistant malaria in tropical countries. A chronic debilitating disease, brucellosis can cause a variety of other symptoms, including joint pain, fatigue and depression. In areas where the disease is endemic, there are substantial losses to livestock producers in affected herds or regions. In most developed countries, test-and-slaughter programmes, together with compensation for farmers and accreditation and financial incentives for disease-free herds, have almost eliminated brucellosis in livestock and few human cases occur.

Cystic echinococcosis (CE) or hydatid disease

Cystic echinococcosis, or hydatid disease, is caused by the larval stage of the tapeworm *Echinococcus granulosus*. Its natural cycle is as a cyst in sheep and as a tapeworm in dogs which feed on infected sheep meat and in turn shed eggs in their faeces, which are then ingested by sheep. Humans become infected by ingesting food or drink contaminated with faecal material containing tapeworm eggs evacuated by infected carnivores, or when handling or petting infected dogs. Cysts often occur in the liver, grow slowly over time and can become very large, with diameters of 20–40 cm. The cure is usually surgery, which is both risky and expensive. Hydatid disease occurs worldwide in communities where sheep are reared together with dogs. Control is through deworming of dogs and preventing them from eating undercooked sheep meat, especially offal, as well as through abattoir control and health education. Hydatid disease causes serious human suffering and considerable losses in agricultural and human productivity. Transmission is facilitated by a general lack of awareness of transmission factors and prevention measures among the population at risk, an abundance of stray dogs, poor meat inspection practices in abattoirs, and improper disposal of offal and home slaughtering practices.

Cysticercosis and neurocysticercosis (NCC)

Cysticercosis is emerging as a serious problem of public health and agriculture in many poorer countries of Latin America, Africa and Asia. Humans acquire *Taenia solium* tapeworms when eating raw or undercooked pork meat infested with cysticerci, the larval form of the tapeworm, which develop in the human intestine where they establish and become adult tapeworms which can grow to more than 3 metres long. The adult worms shed eggs in human faeces, which may in turn infect the same or other humans as well as pigs, by direct contact with tapeworm carriers or by indirect contamination of water or food. The disease is thus strongly associated with keeping pigs in conditions of poor hygiene. Ingested eggs result in larval worms that migrate to different parts of the human and pig body and form cysts (cysticercosis). A principle site of migration in humans is the central nervous system. Human neurocysticercosis, which occurs when the cysts develop in the brain, is considered to be the most common parasitic infection of the brain and the most frequent preventable cause of epilepsy in the developing world. A WHO review of studies reporting the frequency of neurocysticercosis worldwide estimated the proportion of

neurocysticercosis among people with epilepsy of all ages to be almost 30%.. WHO estimates that 10 million of these people with epilepsy live in Africa.

Fascioliasis

Fascioliasis is caused by two agents: *Fasciola hepatica* and *Fasciola gigantica*. *Fasciola hepatica* is found in almost all temperate regions where sheep and other ruminants are raised. *Fasciola gigantica* occurs mainly in tropical areas such as Africa, south and south-east Asia, southern Europe, Hawaii and in the former USSR.

The eggs are excreted with the faeces of humans and other final hosts. They penetrate snails in which they develop into cercariae. The cercariae leave the snail and develop into metacercariae. The definitive hosts become infected by ingesting metacercariae along with plants or water. The definitive hosts of *F. gigantica* are cattle, domestic buffalos, goats, zebras and sheep. The definitive hosts of *F. hepatica* are sheep, cattle and domestic buffalos. Humans can also serve as (accidental) definitive hosts of the two parasites. Human outbreaks have been recorded, mostly related to consuming watercress; recently foci with human-to-human transmission in South America have been discovered. As with the other NZDs, the extent of the problem often only becomes evident when studies are undertaken. Symptoms in humans include abdominal pain, diarrhoea, fever, and chronic inflammation and obstruction of the bile duct.

Leishmaniasis

Leishmaniasis is caused by several species of the genus *Leishmania* found in many areas of the world, particularly in Africa, Latin America, south and central Asia, the Mediterranean basin and the Middle East. Of the 15 *Leishmania* species, 13 can be transmitted to humans via animals. Transmission of the parasite to humans is usually from an animal reservoir harbouring the parasite (small rodents, dogs) through the bites of infected female phlebotomine sandflies. The disease has a wide range of clinical symptoms, which may be cutaneous, mucocutaneous or visceral. Cutaneous leishmaniasis is the most common form. Visceral leishmaniasis, the most severe form, affects the vital organs and is inevitably fatal if left untreated. Leishmaniasis is a poverty-related disease. It affects the poorest of the poor and is associated with malnutrition, displacement, poor housing, illiteracy, gender discrimination, weakness of the immune system and lack of resources. Leishmaniasis is also linked to environmental changes, such as deforestation, building of dams, new irrigation schemes and urbanization, and the accompanying migration of non-immune people to endemic areas.

In its more severe forms, leishmaniasis causes serious disfigurement as well as death. WHO estimates the global prevalence to be approximately 12 million cases, with annual mortality of about 60 000. The size of the population at risk is about 350 million.

Leptospirosis

Leptospirosis is an infection of rodents and other wild and domesticated species. Rodents are implicated most often in human cases. The infection in humans is contracted through skin abrasions and the mucosa of the nose, mouth and eyes. Exposure through water contaminated with urine from infected animals is the most common route of infection. High risk groups are outdoor and agricultural workers as well as urban slum dwellers living in poor accommodation with inadequate street drainage and alongside abundant rodent populations. The number of cases may peak during the rainy season and can even reach epidemic proportions during floods.

Very little is known about the true incidence of leptospirosis. The disease is underreported for many reasons, including difficulty in distinguishing clinical signs from those of other endemic diseases and a lack of appropriate diagnostic laboratory services. Leptospirosis presents with a wide variety of clinical manifestations and can be fatal, but if detected early, the disease can be successfully treated with antibiotics.

Prevention strategies for human leptospirosis include wearing protective clothing for people at occupational risk and avoiding swimming in water that may be contaminated. Control of the disease in animals depends on the type of Leptospira detected and animal species affected, but may be controlled either by vaccination or rodent control, or a combination of these strategies.

Rabies

Rabies is probably the most notorious zoonotic infection. It is caused by a virus that usually enters the body through a bite or skin lesion and migrates to the brain. Its dramatic symptoms in animals and humans and inevitably fatal outcome in untreated patients, have made it by far the most feared of the zoonoses. Perhaps most importantly, rabies is entirely preventable, for which purpose a range of highly effective biologicals has been available for decades. From the public health perspective, vaccinating dogs remains the single most effective measure for preventing human rabies. Wildlife species such as red foxes and raccoon dogs can also be vaccinated, mostly to prevent their transmitting rabies to humans and to domestic animals. In addition vaccination may also be used, after careful evaluation, in some endangered species whose survival is further put at risk by the presence of rabies in these populations (e.g Ethiopian wolves). Various types of post-exposure treatment/prophylaxis exist but are often unavailable in isolated rural areas or too expensive for governments or individuals to afford. In some areas, significant losses to livestock, especially cattle, have been recorded. More than 99% of all human deaths from rabies occur in the developing world, and between 30% and 50% of these are children, with domestic dogs the source of the vast majority of human cases. Despite being one of the oldest diseases known to humans and the existence of highly effective dog vaccines and post-exposure treatments for people, it is estimated that some 55 000 people a year suffer a dreadful death from this disease.

Rift Valley fever (RVF)

Rift Valley fever is caused by a virus that was first identified in Kenya in 1931, from where its name originates. Among animals, the RVF virus is spread primarily by the bites of infected mosquitoes, which can acquire the virus from feeding on infected animals. Humans are usually infected by direct or indirect contact with the blood or organs of infected animals, although they can also be infected by mosquitoes and other biting flies.

Most human cases are thought to be relatively mild and are most often unreported. Those infected either experience no detectable symptoms or develop a mild form of the disease characterized by a feverish syndrome with sudden onset of flu-like fever, muscle pain, joint pain and headache. However, a small percentage of patients develop a much more severe form of the disease. The haemorrhagic fever form (less than 1% of cases). is usually fatal, as witnessed in recent outbreaks.

For livestock keepers, the disease is of major importance: primarily because of the severe losses caused by abortion and death in their animals but also because of the movement and marketing controls that are imposed when it occurs. Sheep appear to be more susceptible than cattle or camels; the rate of abortion in infected ewes is nearly 100%.

These summaries have been compiled from materials on the WHO web site and summaries submitted by scientific experts, notably those who attended the three meetings on NZDs. For further information, please consult the references listed at the end of this report and visit the WHO zoonoses web site: ***http://www.who.int/topics/zoonoses/en/*** *and individual health topics on:* ***http://www.who.int/topics/en/***

In 2000, cases of Rift Valley fever were confirmed in Saudi Arabia and Yemen, marking the first reported occurrence of the disease outside the African continent and raising concerns that it could extend to other parts of Asia and to Europe. Outbreaks are closely associated with periods of above-average rainfall. Forecasting can predict climatic conditions that are frequently associated with an increased risk of outbreaks, and may improve disease control. Livestock can be vaccinated against the disease before an outbreak.

Zoonotic Human African trypanosomiasis (HAT) or sleeping sickness

Unlike the other NZDs listed here, whose distribution is worldwide, human African trypanosomiasis, or sleeping sickness, is limited to the African continent where its insect vector, the tsetse fly, is found. There are two forms of sleeping sickness. The chronic *gambiense* form is found in West and Central Africa and, although infected animals can be found, the disease is maintained by transmission between the insect vector and humans. However, the animal reservoir is important in the acute *rhodesiense* form found in Eastern and Southern Africa. Left untreated, the disease is always fatal in humans; devastating epidemics have occurred during the past century. Treatment is expensive, normally ranging from US$ 150 to UD$ 800 per patient; during the later stages of the disease the drugs used for treating the *rhodesiense* form can themselves lead to the deaths of some 5% of patients. Control is via the vector and the animal reservoirs. For *rhodesiense*, the key to preventing the disease in humans in most areas is by (i) treating the cattle reservoir using medicines and (ii) implementing appropriate vector control measures, many of which can be undertaken by farmers themselves. Both cattle treatment and vector control confer substantial benefits to livestock productivity by controlling the animal forms of the disease.

5 What interventions are available ?

A characteristic of the NZDs is the range of interventions available for the control of each disease. All need to be mobilised for effective control. However, the most cost-effective one is usually to control and eliminate, if feasible, the disease 'at source' that is in its domestic animal reservoir.

There is a need for a closer relationship between the research and control community, for the the NZD and NTD communities and public health to work closely together – we should aim to have to have a synergistic approach and effective coordination.

Chioma Amajoh

PUBLIC HEALTH/ HUMAN INTERVENTIONS

PREVENTIVE CHEMOTHERAPY
Taeniasis
Fascioliasis

PREVENTIVE IMMUNIZATION
Rabies
(Anthrax, Leptospirosis)

CLINICAL MANAGEMENT
All NZDs

AVOIDING RISKY BEHAVIOUR
All NZDs

VETERINARY PUBLIC HEALTH/ ANIMAL INTERVENTIONS

TREATMENT
Cysticercosis
Echinococcosis
Fascioliasis
Trypanosomiasis

PREVENTIVE IMMUNIZATION
Rabies
Anthrax
RVF
Leptospirosis

HOST CONTROL/POPULATION MANAGEMENT
Rodents (leishmaniasis, leptospirosis)
dogs (rabies)
Slaughter of reactors (bovine TB, brucellosis)

EFFECTIVE MEAT INSPECTIONS
Cysticercosis
Echinococcosis

VECTOR CONTROL

Tsetse flies (Trypanosomiasis)
Sandflies (leishmaniasis)
Snails (Fascioliasis)
Aedes mosquitoes (RVF)

ENVIRONMENTAL INTERVENTIONS

IMPROVING ENVIRONMENTAL SANITATION
Stormwater drainage (leptospirosis)
Land drainage (Fascioliasis)
Community-led total sanitation (cysticercosis)

IMPROVING HUSBANDRY PRACTICES
All NZDs

UPGRADING ABATTOIRS AND MEAT INSPECTION
most NZDs such as
Echinococcosis, cysticercosis, bovine TB

In examining control programmes we need to be aware of the engagement of the Ministry of Education and involvement of schools. Children are central in several interventions and their role should be acknowledged.

Charles Waiswa

6 Under-diagnosed and misdiagnosed

A long, painful path is trodden while searching for the right treatment – and the stories we hear are inevitably… the success stories. It is likely that many, if not most sufferers don't succeed in their quest for treatment and for some NZDs this leads to their death. The more isolated their community, the more meagre their family's resources, the more likely this becomes.

"My extended family deserted me and I was labelled a mad man. Even my community deserted me and stayed away, saying I was bewitched and had brought evil sprits to our home."

Bukachi et al., 2009

The high opportunity cost of health-care seeking was confirmed by the facts that people with livestock to look after were significantly more likely to delay seeking treatment, as were people living further away from hospital.

Kunda et al. 2007

For individuals suffering from a neglected zoonotic disease, obtaining health care can be a prolonged and expensive process and for many it is doomed to failure. A number of speakers catalogued the problems encountered by people in this situation. As interest in the NZDs grows, more published studies are becoming available which include interviews with patients eventually diagnosed with a zoonosis about their experiences on the way to obtaining that diagnosis.

Hospitalized patients receiving treatment for acute sleeping sickness (zoonotic human African trypanosomiasis) in Kenya were interviewed (Bukachi et al. 2009). Their tales make harrowing reading. At best, individuals are thought to be possessed by evil spirits: "the traditional healer cut my body and applied herbs to cure this strange illness". As the disease progresses, and repeated attempts at curing it fail, individuals are often thought to have HIV/AIDS: "my husband also refused to take me to hospital, saying he had spent too much money on me and maybe I had contracted HIV". Successful diagnosis can be a random piece of good luck: "a neighbour came across a screening team for human African trypanosomiasis and described my symptoms to its members". The 203 patients in this study tried nearly 700 other options to get better, and were treated for malaria nearly 600 times. Other studies paint a similar picture. In Uganda (Odiit et al. 2004), fewer than a quarter of patients interviewed were referred for testing for human African trypanosomiasis by the health service – most were through neighbours or their own efforts; 67% thought they had malaria and 16% thought it was AIDS. In the United Republic of Tanzania, Sindato et al. (2008), tell of the long search for effective treatment pursued by a Tanzanian worker from Serengeti National Park. He made six visits to dispensaries and hospitals, was treated for malaria eight times, tested for HIV/AIDs, treated for meningitis and even diagnosed with "severe sleep disorder". These stories all relate to individuals suffering from the classic symptoms of a disease that has long been known to occur in these areas. Furthermore, they are the 'lucky' ones, the ones who were found and treated. Others would simply have died and their deaths been attributed to another cause.

A similar story is told for brucellosis. "The majority of brucellosis cases presented to hospital with a long history of symptoms. Some of the cases had been to hospital several times and had received treatment for other diseases such as malaria before being diagnosed as suffering from brucellosis", (Kunda et al., 2007). Nearly half had false negative diagnoses and been treated for other diseases. Because the disease starts with symptoms that patients do not consider serious, many delay visiting the health services. The cases analysed in this study were detected from among febrile patients with joint pain found in the hospital. For those brucellosis patients not enrolled in the study and who did not go to that particular hospital, whether their illness was correctly diagnosis and proper reatment provided remains unknown.

The other side of these tales of prolonged, painful and expensive searches for a correct diagnosis and treatment for a neglected zoonosis is the over-diagnosis of common conditions. In much of the tropics, and particularly in sub-Saharan Africa, this is most often malaria. The case histories in the previous chapter

One of the main reasons why NZDs are under-diagnosed is because they are masked by other more common infections. NZDs are often more focalised, and less well known.

"Current recommendations and associated clinical practices result in massive malaria over-diagnosis across all age groups and transmission areas in Uganda."

Nankabirwa et al., 2009

almost all included several treatments for malaria. In some cases, the patients' blood samples tested positive for malaria, although it was not the main cause of their illness. In other cases, it was simply the easy and obvious diagnosis. Furthermore, in many situations, patients self-medicate or treat their sick children for malaria as soon as they detect a fever. In Africa, it is estimated that 70% of patients with fever initially buy over-the-counter malaria remedies or use traditional medicines for malaria (Amexo et al., 2004).

In recent years interest in the over-diagnosis of malaria has grown. With the introduction of the artemisinin-based treatments, medication for malaria has become more expensive and over-diagnosis is thus increasingly costly. An analysis of 24 papers spanning four continents by Amexo et al. (2004), found an average rate of over-diagnosis rate of malaria of 61% (range, 28% to 96%). More recent studies confirm this: in Sudan, A-Elgayoum et al. (2009) estimated a false-positivity rate for malaria of 76% and in Uganda, Nankabirwa et al. (2009) obtained an average over-diagnosis rate for routine malaria diagnosis of 69%. The studies show errors in clinical diagnosis and in interpreting microscopy results, contributing to a substantial over-diagnosis of malaria. For the control of NZDs this is highly significant, as over-diagnosis of more common infections plays an important role in NZD under-diagnosis. For individual patients with NZDs this exacerbates the difficulties they encounter when they seek treatment for their condition. At the health sector and donor level, misdiagnosis can ultimately lead to misallocation of resources for health care and disease control.

"The effect of malaria misdiagnosis falls most heavily on the poor and vulnerable who are least able to withstand unnecessary prolonged ill-health with subsequent missed earning opportunities and repeated visits to health facilities."

Amexo et al., 2004

© Wen Hao

Increasing people's awareness of less well known diseases: echinococcosis posters in Ganzi hospital, Sichuan Province, China.

7 Improving the clinical diagnosis of neglected zoonotic diseases: an urgent need

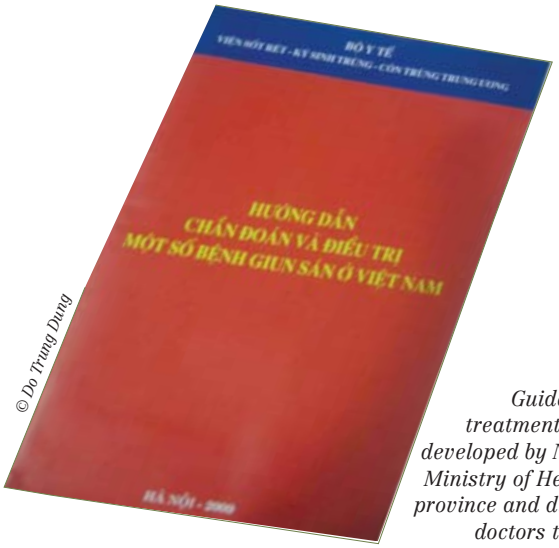
"Increased awareness of diseases among health workers and the community is still the most important area in disease control… Before more weight is put on increasing the diagnostic capacity of diseases, efforts should be made to equip the practitioners and the general community with adequate knowledge of zoonoses"

Kunda et al., 2008

The case histories and studies presented in the previous chapter demonstrate that for many patients with NZDs, obtaining appropriate treatment is a difficult process and many are initially wrongly treated for other, more common, conditions.

A study in the United Republic of Tanzania specifically considered zoonotic diseases (Kunda et al., 2008). Medical practitioners, in selected health facilities within urban and rural settings, were asked questions about the modes of transmission, the clinical features and how to diagnose six zoonoses (anthrax, rabies, brucellosis, trypanosomiasis, echinococcosis and bovine tuberculosis). The results showed 40% of answers by rural practitioners and 31% of those by urban practitioners to be wrong.

During the first NZD meeting in 2005, the need for better diagnostic tests and kits for NZDs was identified as an important constraint. From the studies and discussions at the third meeting in 2010, it is clear that it is at least as important that the "front line" of health services – the medical officers, clinical officers and other medical workers who are based in rural locations or tend to marginalized urban populations who are in contact with animals and at risk of NZDs – receive better training in recognizing the zoonotic diseases they are likely to encounter. Medical services in many of the countries where NZDs are endemic are under-resourced; staff are often transferred to other areas just as they are becoming familiar with local health problems, and most have enormous workloads. However, the large-scale programmes described during this meeting (for example fascioliasis and rabies in China, Peru and Viet Nam) have been successful in motivating and creating awareness of NZDs at the level of local medical services. This has played a crucial role in their success.



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Guidelines for the diagnosis and treatment of fascioliasis: in Viet Nam developed by NIMPE and approved by the Ministry of Health in 2006; distributed to province and district levels, enabling local doctors to diagnose and treat cases.

8 Disentangling the DALYs: investigating under-reporting

The NZDs' DALYs need to be reclaimed from the other diseases to which they have been wrongly attributed.

In Malawi post-mortems revealed that a significant proportion of children who had been diagnosed as having cerebral malaria actually died of rabies.

Mallewa et al., 2007

The complicated health-care seeking paths followed by people with an NZD and the tendency for these diseases to be misdiagnosed, reinforces the need to assess their real burden to humans.

A first step is to gain some idea of what the real incidence or prevalence is. The presentations and discussions during the meeting highlighted the three main approaches that are being applied in various contexts.

Studies of high risk groups thus reveal an avalanche of information on undiagnosed NZDs. Modelling under-reporting only serves to confirm this.

Investigating high risk groups has been the most dramatic, in releasing a mass of information pointing to high levels of unreported illness.

Perhaps the most disturbing account heard during the meeting came from the study by Mallewa et al. 2007, where some 800 seriously ill children whose illnesses apparently involved central nervous system infection were studied. Ultimately, 133 died of the illness with ten (7.5%) of those having been identified as suffering from rabies on clinical signs and history of exposure. Consent to perform post-mortem on all these children was requested from their families and eventually obtained from only 29 of them. Out of those who underwent post mortem 4 new rabies cases were diagnosed in the laboratory. A total of 14 rabies deaths (10.5 %) was therefore confirmed among the 133 deaths. The authors conclude: "Rabies is an important cause of death in children in Malawi, including some for whom cerebral malaria had been diagnosed. Rabies virus should be included in the list of pathogens to consider before diagnosing cerebral malaria."

Modelling indicates under-reporting rates of 40 - 50% for the acute zoonotic form of sleeping sickness (human African trypanosomiasis) are not reported, and 90 – 95% of deaths are unreported. For rabies in the United Republic of Tanzania, up to 99% of human cases are likely not to be reported. For brucellosis in Africa the under-reporting rate is probably even higher than that, since almost all diagnosed cases are a result of special studies on the disease.

In regions where brucellosis is known to be present, simply testing patients with fever repeatedly reveals the presence of brucellosis, as reported by Kunda et al. (2007). Investigating over-diagnosis of malaria in Ethiopia, Animut et al. (2007) note that 2.6% of febrile illnesses were brucellosis, rising to 6.3% in one district. The effect is even more marked if a recognised very high risk group, butchers and abattoir workers, are studied. In Nigeria, studies consistently find high rates of brucellosis seropositivity among butchers, ranging from 30% to 60%. In Pakistan, Muktar and Kokab (2008) found an average prevalence of 22%. When interviewed, affected individuals had usually long suffered the classic symptoms of brucellosis but had never received appropriate treatment.

Surveys of leptospirosis, which was thought to be relatively uncommon, have shown very high rates of exposure, for example, 16% in gold-panning villages in Gabon (Bertherat et al., 1999); while the actual incidence of the disease in Hawaii (USA) is double the reported rate.

One approach to assessing the true incidence of NZDs in areas where there is a high level of under-reporting is **mathematical modelling**, using an appropriate indicator. A number of studies of this nature were discussed during the meeting.

Often the "discovery" that a lot of people are suffering from an endemic disease is mistakenly described as that disease "emerging"or "re-emerging". In fact what has happened is that people are at last being correctly diagnosed and treated for a hidden, neglected, disease.

For rabies, two key studies were cited. Investigating the situation in the United Republic of Tanzania, Cleaveland et al. (2002) used dog bite injuries as a basis for modelling rabies incidence. Using this model, they estimated that while the number of human deaths from rabies reported annually was 10, the overall total could be as high as 1500. This type of modelling approach was extended, alongside other data, by Knobel et al. (2005) to estimate the deaths and DALY burden from rabies in Africa and Asia; the resulting figures of 55 000 deaths annually and 1.7 million DALYs have now become widely accepted.

For zoonotic sleeping sickness (T. b. Rhodesiense human African trypanosomiasis) an under-reporting model has also been developed based on the duration of each of the two distinct phases of the disease (pre- and post- central nervous system involvement) and on the proportion of diagnosed patients found to be in each stage of the disease. The model calculated that in Uganda 40% of patients and in the United Republic of Tanzania 50% of cases were going un-reported (Odiit et al., 2005, Fèvre et al., 2009, Matemba et al., 2010).

For brucellosis, there has been little modelling, although Makita et al. (2010) investigated the contamination of milk in urban Kampala and, from this, modelled an annual incidence rate of 5.8 per 10 000 people.

Finally, obtaining true estimates of incidence or prevalence requires a **systematic population** survey. A number of presentations discussed systematic surveys and campaigns and, in each case, a substantial hidden disease burden was revealed.

Disease	Misdiagnosed as…
Brucellosis	Malaria, flu
Zoonotic sleeping sickness	Malaria, AIDS, meningitis, madness
Hydatid disease	Cirrhosis, liver cancer, amoebiasis
Rabies	Cerebral malaria, madness
Rift Valley fever	Malaria
Neurocysticercosis	Other causes of epilepsy, including witchcraft and spirit possession
Bovine tuberculosis	Human tuberculosis, malaria

9 Quantifying the "double whammy": a must for effective advocacy

Where the dual benefits of controlling NZDs are quantified, the high cost-effectiveness of intervening is very evident. When measured in US$ per DALY averted, the cost-effectiveness of NZD control is very attractive, often in the range of US$10–30.

Zoonotic diseases impose a "double whammy" on society by affecting both people and animals. Effective control programmes thus make it possible to reap a dual harvest from both better human health and improved livestock productivity. Successful advocacy must combine improved information on the real incidence and prevalence of NZDs, corrected as far as possible for under-reporting, and on the other components of the losses imposed on people and animals, that is, the total societal burden of these diseases. Quantifying the double whammy requires information gathering and analysis at three levels.

The first is the **burden of ill health in humans**. This has two components: a monetary component made up of the costs to patients and health services, and a non-monetary component consisting of the value placed on human health, usually measured in terms of DALYs. The DALY, like other measures of human health, was developed in order to provide a standard that can be universally applied across human populations and income groups. For human health, a non-monetary metric is considered ethically sound. Global DALYs, adjusted for under-reporting, have been estimated for five NZDs (cystic echinococcosis, alveolar echinococcosis, leishmaniasis, rabies, and trypanosomiasis); work on others is in progress. The monetary component of the cost of human illness caused by NZDs is particularly high given the frequently lengthy process of getting health care (Chapter 6).

Well established methodologies for evaluating livestock losses exist which can be combined with good information on DALYs. What we need more of is good field data on impact on people and livestock.

The second is analysing the other part of the double whammy in terms of the NZDs' **impact on animal populations**, and the potential benefit their control could bring to animal owners and livestock keepers. For some diseases, this is important, for others not. There are little data from the field about the impact of NZDs on livestock in African, Asian and Latin American production systems, even for diseases such as brucellosis, cysticercosis and trypanosomiasis whose impact is significant. For animals, there is no need to use a non-monetary metric like the DALY. Livestock have a commercial value, and techniques have even been developed for valuing wildlife and companion animals in monetary terms. Livestock's life expectancy is a function of their health, but ultimately of the husbandry system which determines the age at which they are marketed. Money enables different species to be compared; it would be inappropriate to attempt to compare goat DALYs with cattle DALYs and then weigh these against human DALYs. Well established methodologies for evaluating the impact on animal health already exist (see papers and methods set out in Rushton, 2009), removing the requirement to develop novel approaches specifically for zoonotic diseases. Instead, the challenge is to use cost-effective ways of estimating the impact of disease by monitoring key indicators of fertility, asking livestock keepers about mortalities, finding out if draught animals are affected, interviewing butchers and livestock traders, and relating these to measured disease incidence or prevalence in the livestock populations.

At each stage of our work we also need to extract the data which show that these are diseases of poverty. For example, indicators of wealth for affected households and information on their access to health services are valuable for reinforcing the case for urgent intervention.

Alexandra Shaw

Thirdly, there is a need to measure the **impact of interventions** on human and animal disease incidence and prevalence and to **quantify their costs**. Cost calculations need to be comprehensive and credible, including both the cost of the vaccine and its application, of the medicines or operation needed to treat a diseased person in hospital or at home and animals on a farm or in a nomadic herd. Only when these answers are known can the total burden of the double whammy be quantified and the cost effectiveness of interventions be demonstrated.

10 Analysing the burden of rabies

In contrast to the developed world, there is little indication of a realistic resolution over much of the rest of the world, certainly across Africa, given lack of resources, competing priorities, and the lack of a continent-wide movement or strategy.

Louis Nel

The health and economic burden of rabies is difficult to determine as the disease is thought to be vastly underreported for a number of reasons of which some also apply to many other infectious diseases.

- The vast majority of deaths from rabies occur in resource poor countries with inadequate infrastructure and health governance.
- These countries most often also lack diagnostic capacity, leading to a complete absence of laboratory based surveillance in humans and animals and significant inaccuracies or inconsistencies in disease estimation and reporting.
- Rabies is essentially a disease of dogs that have, in the developing world (where these animals are mostly self-supporting), little intrinsic value (compared to livestock, for instance).
- Given the above in particular the lack of data on the extent to which the animal population is affected, estimating total costs associated with the presence of the disease is difficult.

Worldwide, rabies is estimated to account for 1.7 million DALYs.

Knobel et al., 2004

These observations are globally supported by analyses of rabies data reported. For example, country reports submitted to and presented at the international Southern and Eastern African Rabies Group (SEARG) meeting in 2008 revealed a staggering range of 0.019 to 150 when the ratio of human to animal rabies cases was calculated. It is estimated that 95% of human rabies deaths in Africa are not reported. Since human rabies cumulatively makes up more than 10% of the total (human and animal) rabies cases reported from Africa, the degree of underreporting of the disease in animals must be even worse, with probably less than 1% of cases being reported. At the same time, the figures reported to different bodies, such as the OIE, WHO, SADC and SEARG, are essentially never in complete agreement. An example is from 2007, when one country reported 87 animal rabies cases to OIE (World Animal Health Information Database – WAHID – reporting system), 302 to WHO (Rabnet reporting system) and 13 to SEARG

Rabies has the highest case fatality ratio of all infectious diseases. Much of the high DALY burden of rabies is a reflection of the fact that up to half of victims are children with their premature deaths representing many life years lost.

A benchmark study towards the quantification of the burden of rabies in Africa and Asia has been published (Knobel et al., 2005). Using epidemiological and economic models and a series of probability steps, model outputs on mortality and morbidity were used to calculate a DALY score as well as the total societal cost due to rabies (estimated at US$ 583.5 million). Human mortality was estimated to be 55 000 deaths annually. Considering this model, the degree of underreporting is significant indeed and superior to 90% in Africa and parts of Asia.

In recent months, a further community-based assessment of the global burden of rabies has been initiated. This effort is driven by an inclusive global community of rabies experts (Partners for Rabies Prevention) and the study will attempt several additions to the current model. First, to make the assessment truly global and also to evaluate the disease costs in those areas where human mortality is not necessarily high. Second, to add more epidemiological data generated in recent years and to add more information on the cost of vaccination programmes in the developing world. Whereas fixed-point vaccination campaigns were previously assumed across board, updates

from regions where roaming vaccination is required will be considered. In this regard, at least three new programmes, globally driven by the WHO/Gates foundation and the respective governments of the Philippines, South Africa and the United Republic of Tanzania, have been launched during the past two years. New data from India, including epidemiological data and the recent significant reduction of the production and use of nerve tissue vaccine PEP in South east Asia could also comprise important updates.

A child's view of rabies, South Africa

11 Investigating the burden of parasitic zoonotic diseases

Although the global burden for most parasitic zoonoses is not yet known, it is clear is that, collectively, parasitic zoonoses probably have a similar human disease burden to any one of the big three human infectious diseases: malaria, tuberculosis or HIV. In addition many also have a substantial animal health and economic burden.

Paul Torgerson and Philip Craig

Diseases resulting from zoonotic transmission of parasites are common. Humans become infected through food, water and close contact with animals. Most parasitic zoonoses are neglected diseases despite causing a considerable global burden of ill health in humans and having a substantial financial burden on livestock industries. Because of under-reporting it is difficult to estimate what these burdens might be, so published studies tend either to be conservative or to cite a wide range.

Global burdens of cystic and alveolar echinococcosis have been estimated; collectively, they result in at least 1.5 million DALYs and possibly considerably more (Budke et al., 2006; Craig et al., 2007; Torgerson et al., 2010). In addition, cystic echinococcosis results in losses of US$ 0.5–2 billion to the global livestock industry annually. An estimated 40% of the global burden of cystic echinococcosis and 90% of the burden of alveolar echinococcosis falls on a single country, China. Nine provinces of China alone estimate that 330 000 cases of cystic echinococcosis occur annually as well as some 16 600 cases of alveolar echinococcosis. Ultrasound surveys in Tibetan areas of Sichuan and Quinghai indicate a prevalence exceeding 3.5% for both forms of the disease. In some Tibetan communities, echinococcosis is likely to be responsible for the largest burden of any infectious disease. In Tibet, it is estimated to account for an average of 0.81 DALY per person over their lifetime. Elsewhere, cystic echinococcosis has re-emerged in the Newly Independent States of the former Soviet Union and Eastern Europe, and is a major problem throughout the Middle East and parts of Latin America. The incidence of alveolar echinococcosis is increasing in Europe.

Globally, the burden of the two forms of echinococcosis is at least 1.5 million DALYs annually, and may be substantially higher.

Cysticercosis caused by *T. solium*, also causes a major disease burden with perhaps up to one third of epilepsy cases in low- or middle-income pork-consuming countries being associated with neurocysticercosis. China is also highly endemic for cysticercosis. The global burden is unknown but is thought to account for a substantial fraction (around 30%) of the burden of epilepsy in pork-consuming low-income countries, and this figure is confirmed by a systematic review of studies on the frequency of neurocysticercosis (Ndimubanzi et al. 2010). The global burden of epilepsy is estimated at 7.8 million DALYs, of which 6.5 million occur in sub-Saharan Africa, Latin America, South Asia and the Western Pacific (including China).

Other parasitic zoonoses of importance include toxoplasmosis. Studies suggest that congenital toxoplasmosis, which involves mental retardation, epilepsy and blindness, results in approximately 2300 DALYs per year in the Netherlands alone, where it is the leading infectious foodborne disease, surpassing the burden of campylobacteriosis. If other syndromes are included, and with a high global prevalence, toxoplasmosis is likely to make a substantial contribution to the global disease burden.

Some 75 000 or 5% of the 1.5 million DALYs ascribed to sleeping sickness (human African trypanosomiasis) are thought to be due to the zoonotic form

Foodborne trematode infections (liver flukes and other infestations caused by species of *Fasciola*, *Clonorchis* and *Opisthorchis*) are common in some societies and may result in more than 10 000 deaths annually. For fascioliasis, livestock losses alone are estimated to account for some US$ 3 billion.

The burden of schistosomiasis is likely to be revised substantially upwards when the new disability weights developed by WHO are applied. The zoonotic form of schistosomiasis, *Schistosoma japonicum*, accounts for a significant proportion of that burden.

Other major contributors to the burden of parasitic zoonoses are Leishmania spp. and *Trypanosoma spp*. Furthermore, accurate diagnosis or detection of parasitic or microbial zoonoses in humans and animal hosts is critical to assess their burden, especially for active mass screening or epidemiological surveys, but may not always be straightforward.

Mass screening by ultrasound for abdominal echinococcosis in Tibetan communities of north-west Sichuan, China

12 Reviewing the burdens of brucellosis, bovine TB and other bacterial diseases

For brucellosis and bovine TB, advocacy for the control requires better understanding of their health and economic burden. Such information is important for the assessment of the profitability and cost-effectiveness of potential future interventions as most endemic countries have limited public funds.

However, in most countries their importance in terms of burden of disease and societal cost is neither precisely – nor even approximately – known.

Jakob Zinsstag

Bacterial zoonoses such as brucellosis, bovine tuberculosis and anthrax have been successfully controlled or eliminated by effective and well managed vaccination and/or test-slaughter strategies in many industrialized countries. The cost of control was essentially borne by national governments, including the cost of acceptable compensation for culled animals. These zoonoses, however, remain endemic in humans and in livestock in the Mediterranean, Africa, the near East and Central America, and are re-emerging in the newly independent states of the former Soviet Union and Mongolia.

Under the auspices of WHO's Foodborne Disease Burden Epidemiology Reference Group (FERG), the burden of some of these diseases is being estimated or re-assessed. This work should provide estimates for DALYs and global disease patterns. Many countries, however, lack the diagnostic capacity to make a comprehensive estimate of the burden of disease. Individual zoonoses are not categorized in human reporting systems and hence are often not reported as causes in death certifications. Initial work has begun to systematically review the burden of brucellosis by screening some 10 000 articles (after elimination of duplicates) and by selecting some 150 articles for further analysis, of which nearly half relate to Europe. The lack of information on the disease's frequency, especially in Africa, brings it closer to a gap analysis than a full burden of disease study.

Furthermore, along with the other NZDs, bacterial zoonoses have important non-health outcomes in terms of public and private health cost, and costs to agriculture and other sectors of the economy. They also affect foreign trade. Work on the cost of bacterial zoonoses shows different patterns from Central Asia and Africa. The financial costs of brucellosis to society are substantial for countries such as Kyrgyzstan and Mongolia, and are likely to be higher than the cost of effective mass vaccination; Livestock immunization can therefore be justified in financial terms as well as via the impact on human health as measured in DALYs (see Roth et al., 2003). Herd models such as the FAO Livestock Development Planning System can be used to simulate the impact of disease (see http://www.fao.org/agriculture/lead/tools/livestock0/en/).

However, the costs of bovine tuberculosis to livestock keepers seem to be rather moderate and may not justify interventions purely from a financial perspective. On the other hand, private contributions to disease control activities seem possible: Chadian farmers are willing to pay for anthrax vaccine provided its quality is satisfactory. The costs of foodborne bacterial zoonoses such as *Campylobacter* and *Salmonella* are barely assessed economically. A 'One Health' approach, which considers the health of humans and animals as part of a socio-ecological system, supplies the tools for assessing the burden of bacterial zoonoses to human and animal health, including non-health outcomes and the financial cost of disease to society. Such assessments may provide the necessary arguments for decision-makers in low- and high-income countries to adjust interventions not only for clinical management but also to target the root causes of disease, which are mostly outside the human health systems. For example, mass vaccination of livestock, environmental sanitation, abattoir hygiene and food safety are needed to deal effectively with these causes.

13 Understanding the burden of Rift Valley fever: lessons from the Horn of Africa

The economic losses due to the 1997/98 Rift Valley fever outbreak in the Horn of Africa, where economies are heavily dependent on livestock kept by pastoralists, were estimated at US$ 350 million. In 2002, losses in Somalia alone were estimated at US$ 326 million.

The 2006/7 outbreak underlined how severe the disease in humans can be. The mild fever form of the disease probably goes unreported. But among reported human cases the case fatality rate was up to 45%.

Zuhair Hallaj

Rift Valley fever is a mosquito-borne viral zoonotic disease that affects domestic ungulates (sheep, goats, cattle, camels, domestic buffalo) and humans. Large epizootics associated with outbreaks in humans occur during periods of heavy and prolonged rainfall, every 8–10 years historically. Until 1977, the disease was reported only from the east (Horn of Africa) and southern mainland of sub-Saharan Africa. Since then, it has extended its range in three directions: north to Egypt, where an outbreak in 1977 caused an estimated 200 000 human cases, of which 18 000 were reported, including 598 deaths; west to Mauritania and Senegal, where a large epidemic in 1987 caused more than 200 human deaths; east to Madagascar where the disease was first reported in 1979 and where several outbreaks occurred in 1990–1991.

In 1997–1998, a large outbreak occurred in humans in the Horn of Africa, with an estimated 90 000 human cases, including 478 deaths. The associated epizootic resulted in significant losses in livestock, particularly of sheep and goats: approximately 70% died in the affected areas. This outbreak led to the first ban on exports of livestock from the Horn of Africa imposed by the Gulf countries. Given that livestock production and trade are vital to the livelihoods of the region's pastoralists (who constitute a large segment of the area's communities) and are an important source of public revenue, one can understand why the estimated losses caused by that ban amounted to around US$ 350 million. A second ban on live animal exportation was imposed by the Gulf countries after the 2000 outbreak in Saudi Arabia and Yemen which resulted in more than 3500 human cases, including 208 deaths. This second ban led to even larger losses than the first.

Rift Valley fever struck again in the Horn of Africa on a large scale in 2006–2007, causing 350 confirmed human deaths. In 2007–2008, an outbreak in Sudan resulted in a further 230 human deaths. Economic losses in the associated epizootics were great but have yet to be quantified.

Rift Valley fever thus constitutes an important public health problem as well as a serious socioeconomic burden on an area already vulnerable to many natural and human-made disasters.

Country	Reporting period	Reported cases	Reported deaths	Reported case fatality rate (%)
Kenya	2006–2007	684	155	23
Somalia	2006–2007	114	51	45
United Republic of Tanzania	2007	264	109	4
Sudan	2007–2008	723	230	32

14 Leptospirosis: overlooked worldwide

Studies investigating leptospirosis have shown an incidence as high as 975 per 100 000 people in some high risk areas.

Effective control requires much greater awareness and the targeting of vulnerable groups at risk

Bernadette Abela-Ridder

Linked with the presence of rodents and poorly controlled water sourses, leptospirosis is a problem worldwide but remains predominantly a disease of poverty. Inadequate floodwater drainage, poor hygiene and sanitation, over-crowded housing – the characteristics of rural or peri-urban slums – all favour its transmission. Males in their mid 30s are the group at highest risk. During the past five years, significant outbreaks have been recorded across the world ranging from the Americas (eight countries) to Europe and the eastern Mediterranean (nine countries); Africa (one country) and South-East Asia and the Western Pacific (nine countries).

The Leptospirosis Burden Epidemiology Reference Group (LERG) is investigating the burden of the disease. From a review of incidence studies, it is clear that the disease is ubiquitous; particularly high incidence rates are recorded in Africa, parts of the Americas and the Western Pacific (median incidences from published studies of 95.5, 12.5 and 66.4 per 100 000 people). The effect of the disease on patients reveals a substantial proportion suffering acute febrile illness, which may lead to acute renal and/or lung injury. Of the estimated 17% of hospitalized patients who suffer acute lung injury, 25% die as a result. The overall human case fatality rate is estimated at 7%.

Key gaps identified by the Group are:

- point-of-care diagnostics for acute leptospirosis
- insufficient incidence and long-term studies for directly assessing the burden of disease;
- insufficient understanding of environmental and climatic drivers;
- guidance for outbreak response and clinical management;
- protocols for surveillance of disease and infection sources.
- Lastly, vulnerable groups at risk need to be identified and targeted.

Useful websites to visit are:

http://www.who.int/zoonoses/diseases/lerg/en/index.html

http://www.who.int/rpc/evipnet/en/

Moving from a global to a country and then to a community perspective will be vital to contextualize the knowledge gathered in order to increase awareness at the national and community levels among health-care providers and the public, and to guide policy towards improved integrated prevention, control and response.

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Leptospirosis predominantly affects marginalised low-income populations.

Peri-urban living conditions where leptospirosis studies have shown a high incidence, Salvador, Bahia, Brazil

15 Neglected zoonotic diseases and reassessing the Global Burden of Disease

Several individual NZDs are now the subject of expert groups:
- *African trypanosomiasis*
- *rabies*
- *leishmaniasis.*

Many of the NZDs are focal diseases and for these it is particularly important to be careful when estimating the population at risk so that study populations are appropriately matched to at risk populations in order to avoid study population bias. This is a particular challenge for researchers.

Colin Mathers

More information can be found at: www.globalburden.org

The re-assessment of the Global Burden of Disease (GBD) is a major undertaking funded by a US$11 million grant from the Bill & Melinda Gates Foundation, led by the Institute for Health Metrics and Evaluation (USA), WHO, Harvard University (USA), the University of Queensland (Australia), Johns Hopkins University (USA) and the WHO's Health Statistics and Informatics Department. The task involves a complete revision of the Global Burden of Disease, examining all causes, risk factors and disability weights. The work began in 2007 and hopes to be complete within 5 years. The objective is to provide new estimates of disease, injury and risk factors for 1990, 2005 and 2010 for all WHO regions, thus spanning the global population. There are approximately 40 expert groups involving some 350-600 experts.

The DALY will continue to be used as a basic metric, with its two classic components: years of life lost due to premature mortality (YLL) and equivalent years of healthy life lost due to disability (YLD). The YLDs are measured in terms of the duration of disability and the weight of disability. The reassessment will pay particular attention to disability weights. It will derive weights for all unique sequelae in the study (around 230), which capture the major health consequences of all of the causes in the study. The new approach aims to address criticisms of previous approaches by focusing on valuations from community respondents in a diverse range of settings and by using techniques for eliciting responses that are well-matched to the intended measurement construct (loss of health). Thus it hopes to develop a transparent, standardized and replicable approach that will easily accommodate additions or amendments.

This will be particularly important for the NZDs, some of which can involve long term disfigurement (leishmaniasis), others chronic pain or fatigue/ depression (brucellosis). In this context, dog bites from rabies will now be included among injuries, although it is not practical to factor in consequences such as mental anguish while patients wait for the outcome of diagnostic tests to find out if they have or have not contracted rabies. New risk factors, such as genetic predisposition, will be included. Although poverty will not be taken into account explicitly, the regional divisions will provide some basic indication.

To date, the results from the consultation have been encouraging. Large amounts of measurement error in individual responses do not preclude successful estimation of population values. There has been a very high level of consistency in responses across sites. Preliminary analysis of partial results from a telephone survey carried out in the United States indicates further consistency across cultures. Most results yield plausible orderings, while a few implausible results point to important considerations for clarity in the descriptions formulated for the understanding of non-medical people.

16 Rabies: a re-emerging disease in China

90% of human rabies cases occur in remote rural parts of southern China affecting poor farmers and their children.

Yin Wenwu

Following successful control during the early 1990s, the number of cases of rabies in China was reduced to fewer than 200 cases annually by the mid-1990s. Since 2000 however the incidence in humans has risen to a peak of 3300 cases in 2007. Rabies in China is predominantly a rural problem, where the number of dogs per person (1 per 5 people) is four times higher than in urban areas. Only 10% of dogs are registered, predominantly those kept in urban areas. Around 5% of people are thought to be bitten by dogs annually, or some 68 million potential rabies exposures; surveys indicate that fewer than 5% of the dogs implicated were vaccinated.

Lack of knowledge of the disease is a major factor contributing to its re-emergence; people are not always aware that rabies is a fatal disease or of the availability and need for post-exposure prophylaxis (PEP). Furthermore, for people living in rural areas, a full post-exposure prophylaxis regimen (vaccine and immunoglobulin) is often unaffordable costing around1500 Yuan (US$235) for an average per capita annual income around 3000 yuan.

The goal: rabies elimination by 2020!

The capacity of official veterinary services to vaccinate large numbers of dogs is limited. National laws and regulations for humane dog management are lacking, as is integrated laboratory-based rabies surveillance.

Responding to this situation, the public health services have mobilized considerable resources. In 2004, a mandatory national internet-based notifiable disease reporting system was introduced. This is reinforced by sentinel surveillance. In 2006, social mobilization, health education and health promotion activities included a large-scale health education plan. The Ministry of Health also produced national guidelines for PEP in 2006, which were revised in 2009. This work has been accompanied by a national programme of teaching and training on PEP for doctors. The availability of PEP has been greatly increased, especially in the countryside. The public security department is responsible for urban dog populations and the veterinary department for the management, immunization and surveillance of the rural dog populations. NGOs and the public media have also been mobilized.

The key to success is the involvement of all organisations in veterinary and human health fields, as well as non-governmental organizations (NGOs) and the media.

In 2009, the number of human rabies cases had already fallen by more than one third. The Ministry of Health is actively promoting rabies elimination by 2020 as a national goal.

© Xu Zhen

Rural areas have high dog populations and people are often too poor to pay for post exposure prophylaxis if they are bitten.

17 Going for elimination: dealing with rabies in the Philippines

Our goal: to eliminate human rabies in the Philippines and declare a rabies-free Philippines by year 2020.

Raffy Deray

In the Philippines, the passing of a rabies control act and commitment at national level with a multi-sectoral National Rabies Committee, with specific rabies elimination initiatives undertaken by national, provincial and city/ municipal governments, combined with community involvement at the "barangay" level is proving an effective recipe for success.

Rabies remains an important public-health problem in the Philippines. It is the most acutely fatal infectious disease, responsible for the deaths of 200–300 persons annually, almost half of whom are children aged under 15 years. Some 200 000 dog bites are reported annually. PEP for victims of animal bites entails considerable expense, estimated at more than US$ 1.5 million per year by the Department of Health. Despite the limited resources for rabies control, significant gains have been achieved in controlling rabies during the past 15 years. Although cases of human rabies have declined by 60% since 1995, victims of animal bites or rabies exposure presenting at treatment centres have steadily increased. The setting up of these treatment centres, which now number 311, has significantly increased access to PEP; most rabies exposures receive at least four doses of vaccine injected intradermally free of charge. Canine rabies has also been declining, with the number of reported cases of animal rabies down to 40% of their level a decade ago. The Department of Health's rabies budget has quadrupled since 2008, with the passage of the Anti-Rabies Act of 2007.

The National Rabies Prevention and Control Programme is implemented by a multi-agency, multi-sectoral committee chaired by the Bureau of Animal Industry of the Department of Agriculture; a representative from the Department of Health is designated as its Vice-chairperson. Other members include the Department of Interior and Local Government, the Department of Education, the Department of Environment and Natural Resources, local government units, NGOs and people's organizations. Activities are based on vaccinating dogs, providing PEP to victims of dog bites, vaccinating preventively high-risk groups, including school-children, in endemic areas, providing education and information on rabies, and promoting responsible pet-ownership.

The creation of rabies-free zones is an important step in the process. The island province of Siquijor was declared as the first such zone in the country in 2008; Batanes and the Apo Island of Negros Oriental were declared rabies-free in 2010. A further initiative, "Bantay Rabis Sa Barangay", makes a person in the barangay (the smallest political unit of a city or municipality) responsible for ensuring that all dogs are vaccinated.

© Raffy Deray

Pupils unravelling the fatal disease – Rabies. Philippines, 2009

18 Sierra Leone's animal health clubs: a new way to engage communities

The first AHCs were formed in 2008 to commemorate World Rabies Day. They included five schools and seven villages near Njala University. Today, membership comprises primary school pupils aged as young as seven years to university students, along with teachers, lecturers, and farmers in rural communities. There are currently about 100 schools in the Northern, Southern and Eastern Provinces with the AHCs. Njala University is the technical leader and has enlisted the support of nearly 2,000 farmers in AHCs.

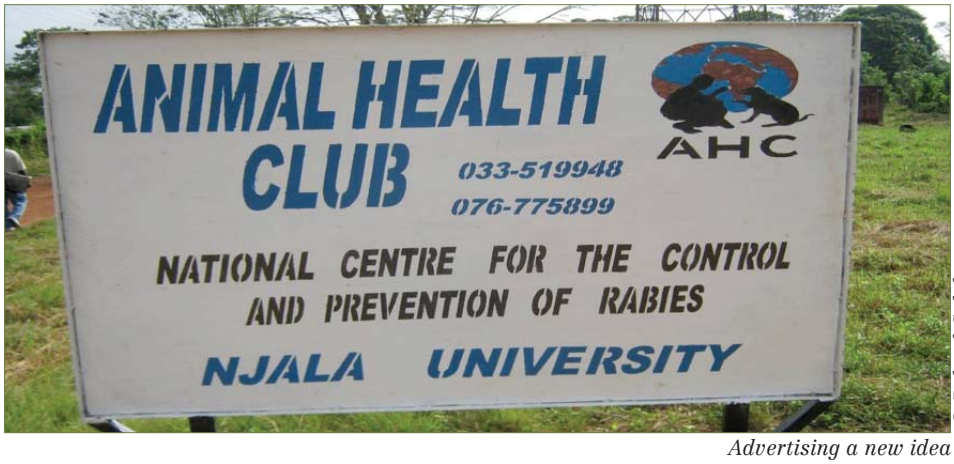
Roland Suluku

In Sierra Leone, the civil war (1991–2002) and the resulting breakdown of all public services have contributed to rabies endemicity in the entire country. Human rabies is not a notifiable disease, so it remains invisible to the public health system and no resources are allocated to its prevention and control. There is no reporting mechanism for dog bites and no standard protocols for dealing with suspected rabid dog bites – neither capture and observation of dogs, nor treatment of human bite wounds and PEP. The problem is compounded by lack of readily available vaccines for either humans or animals. Even when these vaccines are available, most families cannot afford the cost of vaccinating dogs, let alone of human PEP. In 2008, it was clear that rabies was a significant threat to animal and public health.

With the end of the war in 2002, rabies control activities were rekindled in Freetown through the efforts of the Sierra Leone Animal Welfare Society, which launched its Humane Dog Population Management programme in 2005. However it is clear that much more needs to be done. In response to this, a group of lecturers at Njala University, conceived the idea of Animal Health Clubs (AHCs), as an innovative approach to rabies control that engaged and empowered communities to prevent animal and human diseases, focusing on education and raising awareness to prevent dog bites and canine rabies.

The process of establishing AHCs begins with a pilot project, done with the support of the Paramount Chief and his chiefs in the project locations. Head teachers and principals are informed and teachers are assigned to form clubs in their schools. Then, university lecturers train the teachers, students and farmers in animal welfare issues, management, disease prevention and control, environmental management, wildlife issues, animal and human nutrition and appropriate technology. The teachers, in turn, train club members. Large towns are divided into zones - each with an AHC chairperson. On weekends, the teachers, pupils, students and lecturers are divided into teams and sent to work in communities with their zonal chairpersons.

The initial success of pilot projects close to Njala University encouraged the replication of the project in the large towns of Bo, Kenema and Makeni in conjunction with World Rabies Day 2010. The celebration was the first of its kind in the history of Sierra Leone. It attracted people from all walks of life including traditional chiefs and rulers. There was support and participation by representatives of the Ministries of Agriculture and Health, the United States Centers for Disease Control and Prevention (CDC), and FAO.



Advertising a new idea

19 Tackling two neglected zoonotic diseases in Peru: rabies and fascioliasis

The last recorded human rabies clinical case occurred during the first semester of 2006 and only 13 cases of canine rabies were reported during the first 10 months of 2010.

Since 2005 an area comprising 22 departments, accounting for 88% of Peru's land area, 95% of the human population and 95% of the dog population has been free of canine rabies

Ana María Navarro Vela

Rabies

An average of 27 cases of human rabies transmitted by dogs were recorded annually during the period 1990–1994. Since the launch in 1993 of the Urban Rabies Elimination Plan by the Ministry of Health, supported by WHO / PAHO (Pan-American Health Organization), there has been a marked decrease. The last recorded clinical case of human rabies was in 2006, in the Department of Puno, located on the southern border with the Plurinational State of Bolivia. During the same period, an average of 575 canine rabies cases were reported annually. With the launching of the National Elimination Plan, a progressive decrease has been noted and nowadays the canine rabies incidence has been reduced by more than 90%.

Persons bitten by domestic animals, principally dogs, receive appropriate care in all health institutions. During the period 2005–2009 on a yearly average 65 000 people bitten by suspect animals received post-exposure prophylaxis at an estimated cost of US$ 900 000. The observation of biting animals complements the prescription of human post-exposure prophylaxis and is mostly carried out at household level. Dedicated "anti-rabies centres" where dogs and cats are observed are only present in some cities. During 2004–2008 approximately 80% of the biting dogs underwent observation in the departments with high numbers of canine rabies cases.

The success of the plan is based on executing three strategic components:

- paying attention to persons potentially exposed to the rabies virus, prioritizing the clinical observation of biting animals as a complement to post-exposure prophylaxis;
- undertaking free of charge mass dog vaccination campaigns, implemented over short periods of time, using locally produced vaccines and involving the whole health-care system by integrating the efforts and resources of local bodies such as municipalities, universities, armed forces and others;
- strengthening health education for a timely notification of any animal bite and promotion of dog ownership, emphasizing the "triad for the prevention of rabies" (see poster below) with active participation of local governments.

© Ana María Navarro Vela

A poster warning about rabies and explaining what to do if you are bitten by a dog

Publicity is a vital ingredient for success.

A Peruvian stamp with the logo of "World Rabies Day" (WRD) – the release of this stamp was named "the best WRD international event for the year 09" by the Alliance for Rabies Control.

In endemic areas of Peru the prevalence of fascioliasis infestation can be as high as 50% in schoolchildren and over 90% in livestock.
For the first time, infected children, their classmates their family and community members were treated against fascioliasis.

In the study population, before treatment 17% of children and 9% of adults were infected.

The success of the programme depended on intersectoral cooperation, including simultaneously treating animals..

Ana María Navarro Vela

Human fascioliasis

Fascioliasis in Peru is caused by *Fasciola hepatica*, a parasite that commonly affects cattle and sheep and occasionally humans. This disease contributes to aggravating poverty in affected communities. In Peru, high rates of human and animal fascioliasis are recorded, mostly in the departments of Cajamarca and Puno and Valle del Mantaro in Junin department. Prevention and control programmes have mainly aimed at controlling the disease in livestock to reduce its economic impact.

In the recent past control in the human population was difficult as the clinical picture is often not characteristic, existing diagnostic tests have low sensitivity and specificity and because of the absence of a specific treatment.

In 2007, a meeting on the prevention and control of fascioliasis in Peru, with participation of the national and Cajamarca Ministries of Health, Agriculture and Services of Animal Health, the Universidad Peruana Cayetano Heredia and Universidad Nacional Mayor de San Marcos was organized with WHO / PAHO assistance to strengthen inter-institutional technical cooperation. The meeting identified endemic communities in the departments of Cajamarca, Junin and Puno, developed intersectoral prevention and control programmes and proposed for the first time a strategy for the mass treatment of fascioliasis in affected human populations. A triclabendazole donation for the treatment of 600 children of school age was obtained with WHO/PAHO support and used successfully in a pilot project in the endemic areas of Cajamarca between November and December 2007.

Based on this first experience, a methodology for intervention has been established in high risk districts through sampling and testing a sample of the school children aged 6–15 years. When finding a positive case for Fasciola, all the children in the same classroom, all family members and all community members of the positive case were treated. The same methodology was used in a mass treatment campaign thanks to a donation of 200 000 tablets of triclabendazole from Norvatis through WHO.

In 2008 and 2009, through the application of this methodology, 34 792 schoolchildren and adults in two provinces of the department of Cajamarca and 617 people in a province of Junin department were treated against Fasciola using about 123 000 triclabendazole tablets distributed to. During the pilot programme and the following mass treatment campaign no adverse effects requiring therapeutic support were reported. In parallel with this the Cajamarca regional government and the national animal health service have been implementing a project to control hepatic distomatosis in livestock.

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Schoolchildren are a high-risk group in these remote mountain communities

20 Finding an "emerging" problem: fascioliasis in Viet Nam

Three reasons why fascioliasis has been apparently 'emerging' in Viet Nam:

- *awareness of fascioliasis has increased: since 2006, information on fascioliasis was distributed through media to the citizens;*
- *more local health workers are able to diagnose it: training of local health staff has been carried out at provincial and district levels;*
- *improved diagnostic methods: diagnostic tests are available at provincial level and ultrasound is available at the district level.*

Do Trung Dung

Since 2004, work to increase awareness of fascioliasis in communities and to improve the capacity to diagnose it has been undertaken in Viet Nam. From 2004 to 2006, human fascioliasis cases were found in 132 out of a total of 681 districts with more than 80% of these cases found in the centre of the country. Over 90% of the patients were over 15 years of age and about 62% of reported cases were female.

Two different types of freshwater snails were found to act as intermediate hosts, one found in rice fields in both highland and plain locations, the other in small channels. Very high infection rates were found in livestock hosts: up to 98% in buffalo, 71% in goats and 31% in cattle, depending on the location.

The programme involved training health staff in fascioliasis diagnosis and treatment at district and provincial levels in 41 provinces. Most of the hospitals at province and district level have ultrasound and many can diagnose fascioliasis. Since 2004, 52 300 tablets of triclabendazole (for 25 000 treatments) were donated by Novartis through WHO to hospitals in Viet Nam. Information, education and communication (IEC) activities to prevent fascioliasis were carried out at all levels – posters were produced and loudspeakers used to broadcast to villagers.

As result of this enhanced awareness at the community level, better training of clinicians and better diagnostics, the reported cases of fascioliasis in Viet Nam have been increasing year by year: 2007: 1600; 2008: 2250; 2009: 4300.

Now that more and more fascioliasis patients are receiving appropriate treatment, the challenge will be to work on transmission control. First, in collaboration with the veterinary sector, livestock deworming needs to be promoted, although it likely to be difficult to persuade farmers to comply with this. A second option is treating water used in agriculture so as to kill *Fasciola metacercaria*, although there are no good models for achieving this. Lastly, an option would be to convince people to stop eating raw or undercooked vegetables. As people tend to be reluctant to change long-standing eating practices, dedicated health education programmes will be needed

Educating and involving communities: using a loudspeaker to broadcast information about fascioliasis prevention and control to communities.

21 Dealing with a large-scale problem: echinococcosis in Xinjiang, China

A concerted campaign has led to a considerable improvement of the human echinococcosis situation, with human mortality and morbidity gradually decreasing as well as the proportion of infected animals. Echinococcosis is now considered a sporadic disease or a disease of low endemicity.

Hao Wen

Human echinococcosis, both cystic and alveolar, is a significant public health and economic problem in the endemic regions of China (Xinjiang, Gansu, Tibet, Inner Mongolia, Qinghai, Ningxia and Sichuan). Nearly 11 000 cases of echinococcosis were found during the initial national survey in 2004–2008.

In the early 1980s, the People's Government of the Xinjiang Uygur Autonomous Region began to better understand the severity of the problem posed by echinococcosis, and to pay greater attention to its prevalence and distribution. An initial control programme took place from 1986–1995, which included deworming dogs. The government also spent significant human, material and financial resources to control and prevent the disease. Medical and disease prevention specialists worked together and multistage prevention and control measures were established and various treatment methods evaluated.

Analysing hospital data from over 2000 cases, the average direct economic burden was about 12,000 Yuan (US $ 1880) per person, and the indirect economic loss was 11,000 Yuan per person(US $ 1730), equivalent to a total of 2 years average per capita urban income (per capita GNP).

Transfer payments from China Central Government for surgical treatment of human echinococcosis were initiated in 2006. The Health Department of Xinjiang Autonomous Region despatched a group of experts to make an on-the-spot investigation in 40 medical institutions in 29 prefectures. The Xinjiang medical university hospital and Shihezi university medical school hospital were designated "surgical technical guidance hospitals" and 16 other hospitals were also designated for surgical treatment. A computer -based network was used to carry out telepathology (remote) consultations for more than 800 patients. Approximately 500 patients were provided free surgical interventions.

Training programmes, books and audiovisual materials were developed and completed. Relevant training courses were repeated on 12 occasions for the designated medical institution in Xinjiang, Gansu, Tibet, Inner Mongolia, Qinghai, Ningxia and Sichuan provinces. Two technical guidance hospitals also sent experts to provide technical guidance for on-the-spot surgical, imaging, anaesthesia and nursing to designated medical institutions in 7 provinces.

The key to success was providing a model for human health interventions that combined questionnaires, health education, abdominal ultrasound screening and blood tests followed by treatment using percutaneous drainage of echinococcal cysts and surgical intervention, all carried out by a dedicated field team.

Animal health interventions such as dog faeces sampling, testing and dog deworming have also been carried out on a large scale.

© Hao Wen

Free albendazole tablets were given to cystic echinococcosis patients who were found in the Dangxiong survey in Tibet

22 Community-led total sanitation (CLTS): empowering communities

In today's world more people have access to mobile phones than to sanitation.

Kamal Kar

Once a community has been 'triggered', action happens FAST – people don't say – 'oh we'll do this in 6 months'. Latrines are built by the community; the practice of open defecation is stopped by collective community decision and social solidarity. A number of other hygienic practices – such as handwashing – are also introduced. CLTS can act as an entry point for other changes.

Kamal Kar

The CLTS website www.communityledtotalsanitation.org has much information about CLTS in different countries, useful links as well as publications and reports, including Kar (2010).

Lack of sanitation is a huge problem that is seldom talked about. Some 2.6 billion people defecate in the open every day, leaving behind hundreds of millions of kilogrammes of faeces. Lack of effective latrines is linked to a host of diseases – whether via water contamination, direct contact or indirectly, as with a zoonotic disease like *T.Solium* teaniosis/ cysticercosis, whose transmission depends on roaming pigs grazing on human faeces and environmental including water contamination by human faeces.. Many well-intentioned and well-funded projects have, over decades, spent time and money in the world's poorest communities building latrines, providing educational materials, generously subsidizing this work. However, the overwhelming evidence is that these approaches produce neither lasting solutions nor lasting behavioural changes.

The problem lies in "outsiders" expecting to change the behaviour of "insiders". Community-led total sanitation (CLTS) was developed out of the belief, and then the experience, that change can only come from within. The CLTS approach involves a number of simple, but vital steps. Members of the community are brought together and a number of joint activities undertaken, using standard participatory methods.

The methodology involves the community drawing a large map of their village or neighbourhood on the ground showing main landmarks such as a school, mosque/church/temple, roads, paths and water sources. Places of open defecation (OD) are marked and traced to people's homes. Next, the amount of human faecal matter produced per day, month and year by men, women and children is calculated. Families then calculate how much money they spend per month, then per year on treatment of diarrhoea, dysentery and other enteric diseases caused by OD. The main areas of OD are visited and then the possible faecal-oral contamination routes are discussed by adults and children separately, and illustrated or written down. Finally, a meeting takes place where faeces collected during the OD area walk are placed on a plate near fresh food. At this point the cumulative disgust at OD and its implications usually peaks – and the 'triggering moment' is reached, where the community unanimously decides to deal with the problem and to become OD free.

CLTS has now been successfully introduced in 25 countries.

© Philip Vincent Otieno

The first ever CLTS 'triggering' event in the Democratic Republic of the Congo took place in December 2010. It was organized by Tearfund and conducted by the CLTS team from Plan Kenya

23 Using a novel form of cysticercosis control in Zambia and measuring its impact

Overwhelming evidence exists showing cysticercosis is endemic in Zambia. The severe health risks associated with this disease dictate the need to pilot a control programme that allows community participation to ensure capacity building, acceptance and sustainability.

Chummy Sikasunge

In Zambia, pig-keeping has increased rapidly in recent years. Both exotic pigs and the local Nsenga breed are raised. Most pigs are free-ranging and many villages lack proper sanitation. Cysticercosis is endemic in pig-rearing areas of the country. Pork is often consumed un-inspected – hence with cysts.. As yet no evidence is available that human neurocysticercosis, an important cause of epilepsy in the region, is present, but it is likely to be widespread in these endemic areas.

There are no existing community-based prevention and control programmes aimed at controlling NZDs in Zambia. Community-led programmes are a practical and successful way of promoting control strategies in a targeted and sustainable way in both rural and peri-urban areas. It is quite clear that in Zambia, cysticercosis is perpetuated by open defecation (OD). However, plans are underway to introduce a community -led total sanitation (CLTS) approach in two pig-keeping districts (Monze and Gwembe) with support from UNICEF, and, most importantly, to monitor its impact under an EU-funded research project (Integrated control of neglected zoonoses – ICONZ). The aim is to use the principles of CLTS to change people's attitudes and behaviours regarding OD, with the goal of blocking cysticercosis transmission. It is also expected that this will have an important impact in reducing other faecally transmitted parasitic as well as diarrhoeal diseases. Control of cysticercosis could be integrated with that of trachoma since its control is based on improving environmental sanitation and provision of clean water. Improved sanitation also has various indirect impacts such as an improved environment free from odour, faeces and with increased privacy.

CLTS can yield successful results in Zambian communities: A CLTS pilot study reported an increase in the local population using a latrine from 23% to 88% within 2 months. However, the impact of CLTS on disease occurrence has not yet been measured, hence the need to evaluate it. Our research project aims to try and assess the impact of CLTS on T.*Solium* teaniosis/ cysticercosis and on other diseases. It will also record the costs of introducing CLTS to the communities with a view to estimating its cost-effectiveness.

Chibolya livestock market in Lusaka ~ livestock come from all over the country, but many are not inspected before slaughter.

24 The challenge of containing zoonotic trypanosomiasis in Uganda

A potential medical emergency was averted by a partnership involving the Stamp out Sleeping Sickness (SOS) consortium.

This was composed of the Universities of Edinburgh and Makerere, IK/IK Aid and Relief Enterprise Ltd. (IKARE), CEVA Santé Animale, the Ugandan Coordinating Office for the Control of Trypanosomiasis (COCTU) and, since 2010, DFID, working with the Ugandan Ministry of Health, the Ministry of Agriculture Animal Industry and Fisheries and the implementing districts of Uganda.

Anthony Mbonye

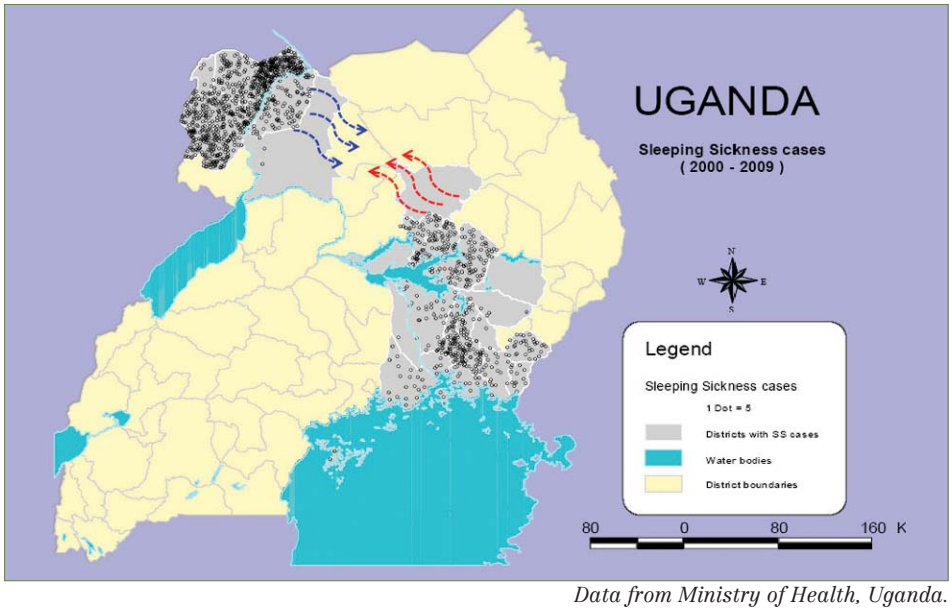
Uganda is the only country in Africa where both the acute zoonotic form of trypanosomiasis (caused by *Trypanosoma brucei rhodesiense*) and the chronic form (caused by T. b. gambiense) are found. As the map below shows, the *gambiense* form of the disease occurs in the northwest of the country, where some 2 million people are at risk, while the zoonotic, *rhodesiense* form is found in the southeast, where some 8–9 million people are at risk. The two forms of sleeping sickness have always been distinct and separate. However, since 1998 there has been a gradual expansion north-westwards of the *rhodesiense* form of the disease, with districts north of Lake Kyoga (in the centre of the country) being affected for the first time. Cattle are the main reservoir of T.b. rhodesiense which is transmitted to humans from cattle by tsetse flies. This north-westwards spread of the *rhodesiense* form of the disease occurred as a result of resettlement and restocking of cattle populations which marked the end of civil unrest in the region.

Sleeping sickness is a human disease whose epidemiology is characterised by a tendency for a small number of cases to usher in a massive epidemic. During the course of African history such epidemics have depopulated whole areas – and Uganda has suffered several outbreaks of this type. Thus, the appearance of isolated cases of zoonotic trypanosomiasis in areas where it had never before been seen, and the steady progression towards the northwest where the *gambiense* form of the disease is found, needed be treated with extreme seriousness. Diagnosis of the disease is complex, under-reporting considerable and the two forms require different treatment. Undertaking differential diagnosis and trying to contain an epidemic where the two forms overlapped would pose an enormous and expensive medical challenge.

In order to deal with the situation two main strategies were used:

- block treating cattle populations to clear the pathogen from the reservoir population, reinforced by treating cattle at markets to prevent reintroduction
- vector control, with the technique of choice being spraying cattle with an insecticide which was popular with farmers because it controls ticks as well as tsetse flies.

By 2009 the number of new human cases had fallen by 75% and the spread of the disease had been halted.



© Albert Mugenyi

Data from Ministry of Health, Uganda.

25 A successful public–private partnership: IKARE and Stamp out Sleeping Sickness in Uganda

The three key components in SOS's success have been:
- *a sense of urgency*
- *strong and active partners*
- *alignment of interest.*

Anne Holm Rannaleet

"We have all started and legalized our businesses which have changed the lives of our farmers and ourselves. We now feel more relevant and have addresses. I have particularly liked the whole venture because it has kept me awake, busy and a lot more responsible."

Emanuel Isingoma, SOS Vet

IK Aid and Relief Enterprise Ltd (IKARE) is an independent charity founded in 2006. Its main sponsor is IK Investment Partners, a leading European private equity firm. IKARE's aim is to transfer private equity investment techniques and key business concepts into the causes it supports. Its resources are currently fully dedicated to Uganda's SOS initiative. This project has been partly described in Chapter 24 above.

IKARE's particular role has been in finding a business model for delivering the two interventions – treating cattle with trypanocides and spraying them with an insecticide to control tsetse and ticks – which have made it possible to successfully halt the north-westward spread of zoonotic trypanosomiasis in Uganda. Initially an emergency intervention involving treating 250 000 cattle was undertaken. Drugs and sprays were donated by CEVA Santé Animale. It was then necessary to find a sustainable model which ensured that these interventions were taken up and funded by local cattle keepers. To do this, communities comprising some 1.7 million people had to be contacted, and made aware of the risks of sleeping sickness to people and of animal trypanosomiasis to their livestock, and of the benefits that the treatment and regular spraying of cattle with insecticide could bring to animal and human health. During this work it became evident that these communities generally needed a better supply chain of veterinary drugs and animal health services and inputs.

The solution was to recruit five young graduate veterinarians. Each was allocated to an area. They received training in basic business management as well as start-up funding. In addition to supervising and coordinating the cattle spraying activities undertaken by farmers and by a network of field spray assistants, the veterinarians sell other veterinary products and advise livestock keepers and treat their animals. The SOS distribution network now includes 80 field spray assistants running their own businesses which have been set up with micro-financing. Some 20% of the cattle in the area are now regularly treated – a sufficiently high number to control transmission of sleeping sickness. SOS has now been incorporated into the Ugandan Government's five-year plan "Prosperity for All".

A successful intervention tackling a deadly disease of humans by controlling the animal reservoir and the insect vector.

Delivering veterinary services to the farmers in remote rural areas: Dr Were in front of his newly opened shop.

© Pierre-Loup Lésage

26 GALVmed: harnessing the private sector to develop vaccines for neglected zoonoses

In spite of the crucial link between animal health and human health, between livestock and livelihood, only 4% of international aid is directed to agricultural needs in developing countries. And only a tiny part of this goes to livestock

Johan Vanhemelrijck

Further information can be found at:
www.galvmed.org

A not-for-profit global alliance of public, private and government partners, the Global Alliance for Livestock and Veterinary Medicines (GALVmed) is protecting livestock and saving human lives by making livestock vaccines, diagnostics and medicines accessible and affordable to the millions for whom livestock is a lifeline. With offices in the United Kingdom and Africa, GALVmed is currently funded by the Bill & Melinda Gates Foundation, DFID and the European Commission (the latter through the AU-IBAR – the African Union Interafrican Bureau for Animal Resources).

GALVmed's role is to provide leadership to overcome the challenges to making new veterinary products available by creating partnerships which provide poor livestock keepers with access to animal health products.

GALVmed began operations in November 2005. Since then, it has played an integral role in increasing the resources dedicated to the development of diagnostics, vaccines and medicines to tackle livestock diseases. GALVmed focuses on 13 key diseases that are most relevant to poverty reduction in target areas. These 13 diseases are broken into four categories: avian, swine, small ruminant and cattle diseases, although some of them affect more than one category. The loss of livestock due to these infections is devastating to the existence of their owners, making vaccinations and treatment crucial to the economic and physical well-being of the farmers.

Three of the 13 target diseases are NZDs: porcine cysticercosis, Rift Valley fever and trypanosomiasis.

For Rift Valley fever, vaccine candidates and a pen-side diagnostic are being investigated. The vaccine candidate is a multivalent vaccine with lumpy skin disease and sheep and goat pox – which would increase uptake, and a monovalent emergency Rift Valley fever vaccine. The pen-side diagnostic needs validation according to OIE procedures, after which manufacturing and distributing partners will be selected and the assay validated in one country before dissemination and distribution begin.

For porcine cysticercosis, the TSOL18 vaccine has been the candidate selected (Lightowlers et al. 2003). Agreements have been reached in principle and trials are planned to start during 2011. For medication, oxfendazole has been chosen as the drug of choice. However, it is currently not registered for pigs at a single dose of 30 mg/kg. Pharmokinetic and residue studies are being undertaken and animal trials have been finalized. It is planned to expand the label claims for oxfendazole so as to increase both commercial interest and access by poor farmers. Contacts with potential manufacturers have been initiated.

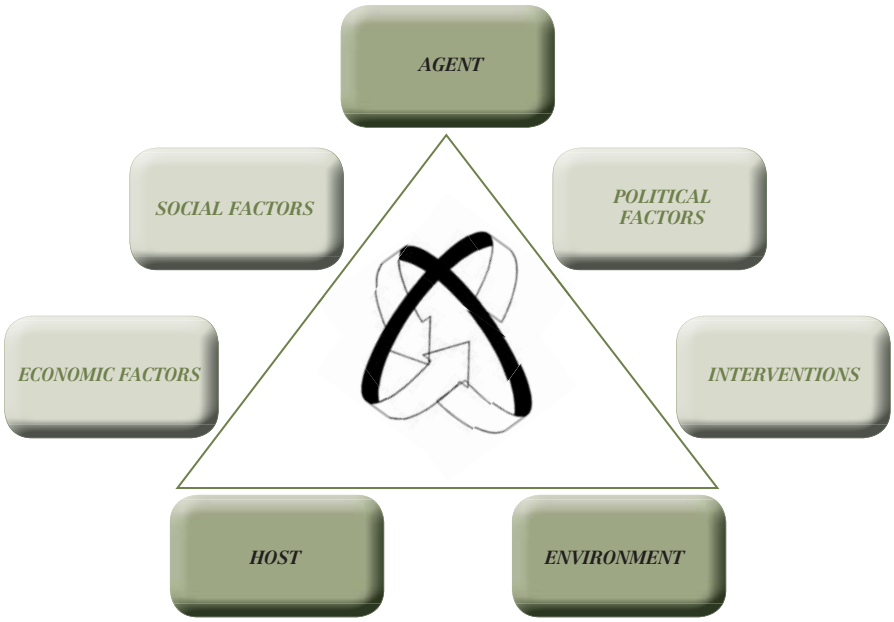
27 WHO's work at the human–animal health interface

Effective surveillance needs to incorporate and react to signals from multiple sources – thus forecasting Rift Valley fever outbreaks in Africa would use remote sensing, climate and vegetation data.

Cathy Roth

Understanding, predicting and controlling diseases at the human–animal interface is a huge challenge in today's world, where international trade and travel have globalised disease. WHO is involved at many levels:

- defining policies and sustainable programmes for the prevention and control of priority zoonotic diseases in humans;
- strengthening early detection, characterization and response to animal related public health risks, including outbreaks;
- developing international and national capacity, tools and mechanisms for the assessment and reduction of zoonotic diseases associated health risks.



Surveillance and outbreak prediction are a major component of WHO's work on the human–animal interface. Effective outbreak prediction often depends on a multiplicity of signals. A number of networks and associations have been set up such as. The Global Early Warning System (GLEWS) which formally brings together human and animal health systems to trigger appropriate action, provide timely, coordinated, information-driven decision-making to avoid or decrease the zoonotic disease burden. A variety of human and animal surveillance data and environmental monitoring/detection systems for forecasting/prediction is needed to identify potential 'hotspots'. However, even when risks are identified, an adequate underlying infrastructure and resources are required to take the measures needed if outbreaks and emergencies are to be prevented or controlled.

Collaboration is a prerequisite. This takes place internally across departments, clusters and regions at WHO, externally with FAO, OIE, and other international agencies, with networks, NGOs, academia, other partners and with national agencies, institutions, and ministries. Together FAO, OIE and WHO are augmenting their collaboration for promoting a coordinated approach to reducing risks of disease transmission at the animal–human–ecosystem interface. A strategic agreement outlines the sharing of responsibilities and enhanced coordination of complementary roles and activities between FAO, OIE and WHO at national, regional, and global levels.

28 Renewed emphasis at TDR on neglected zoonotic diseases in tropical diseases research

For NZD research the three top priority areas are:

- *estimating the burden of zoonotic diseases going beyond DALYs to include monetary losses to humans and animals, nutritional impacts (milk, meat losses), manure and cash assets;*
- *assessing the cost effectiveness of health-care delivery methods for the control of zoonoses and marginalised infectious diseases of poverty at community level;*
- *promoting intersectoral collaboration (health, livestock, agriculture, natural resources and wildlife), cross systems policy and prioritization.*

Ayoade Oduola

For further information visit TROpIKA, a "one-stop shop for knowledge sharing" at www.TropIKA.net or read about the Global Report on Research for Infectious Diseases of Poverty http://apps.who.int/tdr/svc/news-events/news/global-report

TDR – the UNDP/UNICEF/World Bank/WHO Special Programme for Research and Training in Tropical Diseases has recently produced its new research strategy, which incorporates a renewed emphasis on zoonotic diseases. The objectives to be delivered fall under three headings.

1. Stewardship: for research on infectious diseases of poor populations through harmonized global research efforts;
2. Empowerment: of researchers and public health professionals from disease endemic countries with research leadership in those countries;
3. Innovation: enhanced access to superior interventions – including strengthening of health services.

The concept of stewardship for research on infectious diseases of poverty aims to coordinate and harmonize research efforts. It hopes to achieve a coherence of priorities, agenda and support as well as collaboration among stakeholders, so that research works effectively in creating "options for action" against diseases of poverty. Equitable access to research information underlies this strategy, with the objective of ensuring that enhanced resources are allocated to research on the diseases of poverty, that this work is supported by the governments of disease endemic countries and, ultimately, that these countries make use of the research outputs.

TDR is using a think tank approach to defining what the research needs and priorities are within each topic. Each think tank is supported by a reference group. The NZDs have their own reference group consisting of seventeen scientists representing all WHO regions. The areas of core expertise which need covering for the NZDs are veterinary public health, veterinary laboratory science, wildlife biology, epidemiology/public health, social sciences (medical anthropology), community medicine and health (geography), clinical medicine (infectious diseases), parasitology/microbiology/genomics and genetics (laboratory), health/agriculture/livestock economics, water/sanitation and diagnostics.

The table below shows how for a series of epidemiological research components the rankings might be prioritized for some zoonotic diseases, including NZDs – it is intended as an example, not a definitive analysis.

Research components	Cysticercosis /taeniasis	Echinococcosis	Rabies	Brucellosis	Toxoplasmosis japonica	Schistosomiasis	Foodborne trematodes
Burden of disease in humans and animals	++++	+++	++	+++++	+++	+++	++++
Innovations in surveillance	++++	++++	+++	+++	+++	++++	++++
Prevalence mapping and spatial analyses	+++	+++		+++		+++	+++
Risk factor analyses	++	+++				+++	+++
Evaluation of interventions	+++	++++	++	+++++	++	++++	+++
Contribution to non-communicable conditions	+++++	++	+	+++	+++	++	+++++
Transmission dynamics models	++++	++++	+	+++++	+	++++	+++++

29 ICONZ: 21 partners dedicated to improving control of neglected zoonoses in Africa

As we reach out to marginalized populations, public engagement with all stakeholders is essential for ensuring that culturally appropriate measures for dealing with these diseases are adopted into the policy frameworks of all affected countries.

Sue Welburn

Further information can be found at: http://iconzafrica.com/

In April 2009, a large multi-centre research project was launched in Edinburgh, funded by the EU under its Framework 7 (FP7) programme. ICONZ "Integrated Control of Neglected Zoonoses in Africa" was largely inspired by the 1st and 2nd Neglected Zoonotic Diseases meetings held in Geneva and Nairobi. The ethos of these meetings informed both our objectives and choice of diseases. ICONZ is researching eight neglected zoonoses, grouped into four clusters, so that added value can be gained from combining control and research activities:

- bacterial zoonoses (anthrax, brucellosis and bovine TB)
- dog/small ruminant (rabies, cystic echinococcosis and leishmaniasis)
- pig-associated diseases (T. Solium cysticercosis/taeniosis)
- vector-borne diseases (zoonotic trypanosomiasis, with spill-over effects from vector control onto malaria in people and tick-borne diseases in cattle).

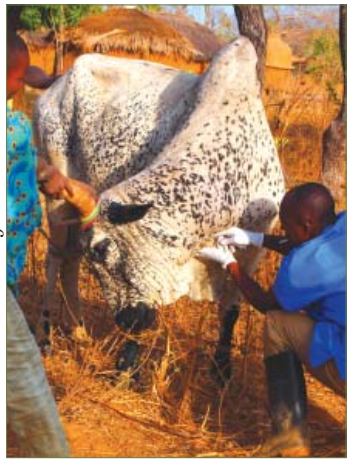
ICONZ has study sites in Mali, Morocco, Mozambique, Nigeria, Uganda, the United Republic of Tanzania and Zambia. Its partners are leading research institutes working on zoonoses in each of these countries and European institutes with expertise in diagnostics, disease control tools and applied epidemiology. Its activities include:

- creating an inventory of and mapping global research on the NZDs, with a view to collating existing knowledge and identifying gaps
- reviewing existing tools for diagnosing and controlling these diseases and identify areas for improvement
- updating knowledge of and further investigating these diseases' burden in people and their costs to livestock production.

Central to ICONZ's work are field-based case studies in Africa which will consist of three phases:

- an investigation of disease prevalence in livestock, linked as much as possible with work being done on the disease in people;
- baseline surveys on relevant livestock productivity indicators and on people's knowledge, attitudes and practice to the diseases under study;
- the trial of an intervention in the study areas, followed by assessing impact and cost with a view to demonstrating cost-effectiveness.

In the field a key role in the case study research is being played by students – and capacity building at all levels is an important component of ICONZ. The final phases of ICONZ will focus more on public engagement – investigating how the disease control strategies can be better integrated into the work of existing medical and veterinary health services and on influencing policy makers.



© Marie Julie Ducrotoy

Working in Nigeria investigating brucellosis in a pastoralist community

30 Research on neglected zoonotic and infectious diseases supported by the European Union

Efforts should continue to ensure a multidisciplinary approach. Socio-economic, cultural/religious and anthropological aspects are key disciplines for the successful control of NZDs. To these must be added the active involvement of local communities. The cutting edge "omics" research alone is not enough.

International organizations and other key players should make efforts to unite forces beyond traditional political groupings to benefit the most impoverished populations of the planet who are the major sufferers from these diseases.

Isabel Minguez-Tudela

The successive European Union Framework Programmes for Research and Technological Development have supported research into diseases classified as "Neglected Infectious Diseases" and "Neglected Zoonotic Diseases". Information is provided on the ongoing projects supported by the EU 7th framework programme for research 2007–2013 (FP7) in the "Health" and "Food, Agriculture and Fisheries and Biotechnologies" themes.

In the "Health" theme there are four areas of research into infectious diseases in humans:

- poverty-related diseases (HIV/AIDS, malaria, TB);
- anti-microbial drug resistance;
- potentially new and re-emerging epidemics: viral diseases ;
- neglected infectious diseases (NIDs): helminth, bacterial and protozoal diseases.

Among the NIDs, the priority diseases targeted are: helminth diseases (lymphatic filariasis, schistosomiasis, ascariasis, trichuriasis, hookworm), protozoal diseases (trypanosomiasis, leishmaniasis, Chagas disease) and bacterial diseases (Buruli ulcer, leprosy, trachoma and infantile diarrhoea). These projects aim to contribute to the long-term control of NIDs and include (i) transnational research for drug and vaccine development and (ii) research on disease control including diagnostics, vector control and health systems research.

The work under FP7 can be accessed at: http://cordis.europa.eu/fp7/home_en.html

To find out more about the work on NIDs visit: http://ec.europa.eu/research/health/infectious-diseases/neglected-diseases/index_en.html

In the "Food, Agriculture and Fisheries and Biotechnologies" theme neglected zoonoses are included as a priority under animal health research. The most relevant project is ICONZ (see Chapter 29). In the call for 2011, a topic has been included on focusing training programmes for researchers working on NZDs in order to "create a culture of collaboration" between the animal and human health sectors. Other EU projects are targeted at improving the tools and knowledge of specific diseases of livestock present in the developed and developing countries such as bovine tuberculosis (TB-STEP) and helminth infections (PARAVAC) which addresses fascioliasis and echinococcosis, among others.

Information about DISCONTOOLS can be found at http://www.discontools.eu/home/index

and about ETPGAH on http://www.etpgah.eu/

There is a number of other EU projects of great relevance to the control of NZDs. One such project is DISCONTOOLS, which emanates from the European Technology Platform for Global Animal Health (ETPGAH). It has provided a mechanism for focusing and prioritising research that ultimately will deliver new and improved vaccines, pharmaceuticals and diagnostic tests, based on gap analyses of 49 diseases, of which 10 are NZDs. The European Commission strongly supports coordination of research funders at both the European and international level. Another such project is MED-VET-NET, where successful collaboration has been established between animal health and human health research, mainly on foodborne diseases.

MED-VET-NET is described at http://www.medvetnet.org/cms/

31 Neglected zoonotic diseases in the broader picture of agriculture and human health: the CGIAR's vision

The basic concept driving the CGIAR research programme "Agriculture for improved nutrition and health" is the idea that agriculture practices and interventions can be adapted to maximize health and nutrition benefits and reduce health risks.

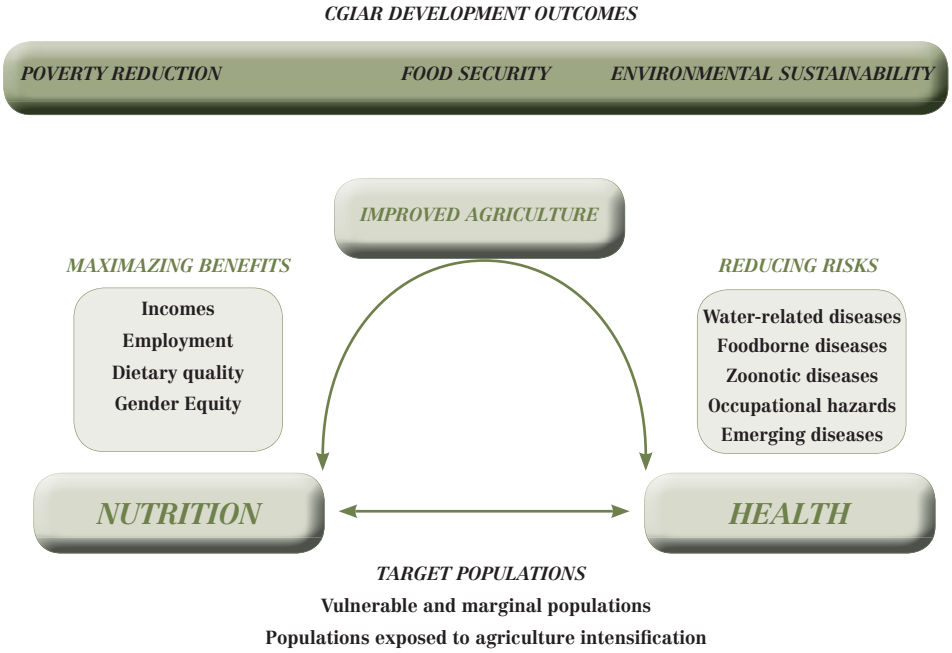
With respect to the NZDs research will focus on:

- *better quantification of the multiple burdens of neglected zoonoses and benefits of their control;*
- *research into evolving zoonotic disease risks as agricultural systems intensify;*
- *improving control strategies and how they can be delivered within a broader development agenda.*

John McDermott

In late 2008, a major change process for the Consultative Group for International Agricultural Research (CGIAR) was initiated. The purpose was to provide more coordination between researchers by bringing the 15 individual research institutions together in a legally constituted consortium and in aligning its more than 60 funders in a Fund Council to support longer-term and larger research programs with greater focus on development outcomes and impacts.

As part of this change, larger research programmes are being formulated. Some of these relate to the traditional strengths of the CGIAR in enhancing agricultural productivity. Others are responding to evolving challenges such as water scarcity, land and forest degradation and climate change. One new programme which specifically incorporates NZDs is called: "Agriculture for improved nutrition and health". This programme focuses on how agri-food systems can be shaped to promote better human nutrition and health outcomes.



Overall, the CGIAR research contributions to agricultural development are designed to improve food security, reduce poverty, and improve environmental sustainability and these development impacts are directly linked to health and nutrition impacts. An important goal of this programme is to bring a health and nutrition focus to the overall CGIAR, to inform partners' efforts to better shape agri-food systems so as to maximize development impacts.

Shaping future agri-food systems will involve addressing trade-offs between maximizing different agricultural benefits and minimizing risks. This programme will provide evidence and intervention options for managing these trade-offs from a health and nutrition perspective, targeting two specific populations: (i) marginal and vulnerable populations and (ii) populations affected by agricultural intensification.

32 OIE's commitment to dealing with neglected zoonotic diseases

Veterinary Services (VS), in fulfilling their veterinary public health responsibilities, are a critical component in the control of these diseases, for the benefit of both animal and human health. A competent VS functioning under a system of good governance is a Global Public Good.

Kathleen Glynn

All the seven major diseases in WHO's initial list of NZDs are OIE listed diseases. Anthrax, rabies, and cystic echinococcosis are notifiable to the OIE for multiple different animal species, while bovine tuberculosis, brucellosis, cysticercosis and African trypanosomiasis are listed diseases for selected species, for example in bovines or in swine. This means that for each of these diseases, the OIE provides Members and the broader veterinary community with science-based guidance on their detection, surveillance and control, including international standards related to the safety of trade in animals and animal products.

Two key components of OIE's activities are of particular relevance in the fight against neglected zoonoses. Due to the hard work of national Veterinary Services (VS), we have seen much success in the control of certain animal diseases in different regions; however, many endemic animal diseases continue to be present, requiring that we do not lower our vigilance. The OIE has produced guidelines for the evaluation of the Performance of Veterinary Services – the PVS tool – which aims to promote and facilitate good governance within veterinary services.

Twinning provides a link between an OIE reference laboratory or collaborating centre and a national laboratory wishing to improve capacity and expertise for an OIE listed disease or sphere of competence.

In the case of zoonotic diseases, the efforts of the national VS should clearly be carried out in strong collaboration with public health partners. PVS missions follow a pathway towards achieving efficient VS:

- evaluation, or "diagnostic" phase
- gap analysis or "prescription"
- selected interventions or "treatment", which may include a strategic plan, modernising legislation, public–private partnerships, country/donor investments/projects, veterinary education and laboratories.

The OIE's rabies information including guidelines are available online in English, French and Spanish

http://www.oie.int/eng/info_ev/en_Rabies_Control.htm

http://www.oie.int/fr/info_ev/fr_Rabies_Control.htm

http://www.oie.int/esp/info_ev/es_Rabies_Control.htm

A second key element is diagnostics – already identified as an important bottleneck for effective NZD control. There are 190 OIE reference laboratories in 36 member countries or territories, providing expertise on 100 OIE listed diseases. In addition there are 37 collaborating centres from 20 member countries or territories which provide expertise in a specific designated sphere of competence such as epidemiology or risk analysis.

Finally, OIE is involved in a number of rabies related activities

33 Veterinary public health and neglected zoonotic diseases at FAO

As this group of diseases is closely linked to poverty and the lack of access to information, services and resources, FAO is committed to address these diseases through fostering development, income generation and protecting peoples' livelihoods and food security.

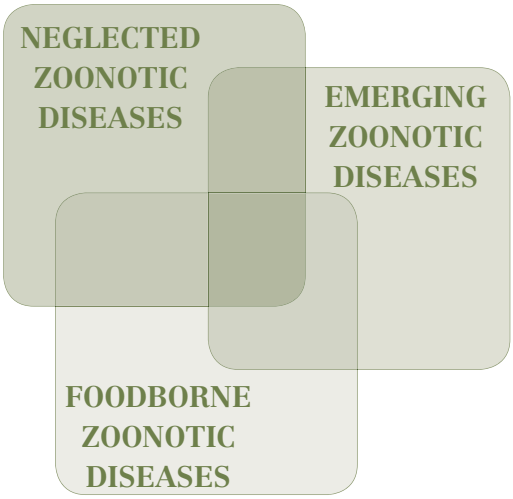
How can services and interventions be delivered in poor and marginalized areas?

How can public awareness be enhanced and acceptable, practicable and cost-effective interventions be found?

The rapid rise of new technologies such as mobile phones and internet access provides unprecedented opportunities in developing countries.

Katinka de Balogh

The Animal Production and Health Division at the Food and Agriculture Organization hosts the Animal Health Service. In 1999 the position of an Animal Health Officer dedicated to Veterinary Public Health was created within the Parasitic Diseases Group. Another position on bacterial diseases within the Infectious Diseases Group addressed brucellosis and anthrax alongside a number of other bacterial animal diseases. With the rise of highly pathogenic avian influenza (HPAI/H5N1) in 2003, the importance of especially addressing emerging zoonotic diseases was recognized globally. Unprecedented resources were mobilized for a zoonotic disease with potential pandemic spread. Furthermore, the need to address diseases in animal populations before they impact human health was recognized and the establishment of inter-ministerial committees and task forces in many countries enabled the coordination of the different sectors primarily involved in addressing HPAI/H5N1. In addition to animal and human health, sectors dealing with wildlife, emergency procedures and finances were brought to the table.



The FAO approach to zoonotic diseases has followed the typology illustrated in the figure. Each group of diseases requires a different approach.

- For the neglected zoonoses, better health systems, development and poverty alleviation measures and public awareness are needed.
- For the emerging zoonoses, emergency preparedness, early detection and rapid responses are essential.
- For the foodborne diseases, control is via the food chain, consumer empowerment and certification.

Some NZDs fall into several categories. Thus anthrax and brucellosis fit into all three. Cysticercosis and bovine TB are also foodborne, and rabies, RVF and leishmaniasis are also emerging zoonoses in some areas.

Many of the lessons learned from HPAI/H5N1 can also be used for addressing other zoonoses. The importance of good surveillance systems and laboratory facilities for early detection as well as functioning services that will be able to rapidly respond to any new event have been recognized. Nevertheless while much attention and funding is directed in detecting unusual events, there continues to be the need to engage in finding better prevention and control strategies to address the neglected zoonoses.

34 From the global response to influenzas towards One Health: initiatives of the European Commission

The post avian influenza context and 'One Health' concept provide a window of opportunity to streamline the prevention and control of NZDs.

Alain Vandersmissen

The European Commission and the European Union as a whole have been a major global actor in the response to the influenzas crises, both politically and financially, linking crisis prevention and response to long-term capacity building and improvement of livelihoods. The One Health movement has in many senses grown out of the response to these crises. The definition of One Health chosen by the European Commission in its external relations and actions reads as follows: the One Health approach consists of (i) improving health and well-being through the prevention of risks and the mitigation of the effects of crises that originate at the interface between humans, animals and their various environments; (ii) for that purpose: a) promoting a multi (cross) sectoral and collaborative approach; and b) promoting a "whole of society" approach to health hazards, as a systemic change of perspective in the management of risk. At the international ministerial conferences on avian/animal and pandemic influenza (IMCAPI) of New Delhi, Sharm-El-Sheikh (2008) and Hanoi (2010), the European Commission made declarations at the international level in support to the One Health approach in its external relations policies. Those statements include the following key political points of relevance in the battle to control NZDs:

- *One Health is linked to livelihood and equity: there should be no resignation vis-à-vis the existence of different health standards across nations.*
- *One Health fits with EU objectives: to promote global security, social justice, international cooperation, multilateralism and fight poverty.*

'One Health' is a first step towards improving health outcomes incorporating human and animal health policies in all relevant sectors

Hanoi Declaration April 2010.

Neglected zoonotic diseases are by definition an important topic covered by the One Health approach. The Commission believes that the criteria to address them specifically in projects and programmes will largely depend upon the appropriate advocacy by technical agencies that should be based on cost/benefit analyses. Those analyses should also address the political cost of "no action". Finally, the current One Health regional action programme in Asia (2009-2012) on Highly Pathogenic Emerging or re-emerging Diseases (HPED) is not limited to any given disease. Should ASEAN, SAARC or their member countries wish to include one or more NZDs, this can easily be done. The agencies responsible for such actions are OIE, FAO and WHO as implementing agencies, together with the ASEAN and SAARC secretariats and the national authorities covering public and animal health, as leaders of the programme.

On the ground, there is a need for systematic collaboration between strong and autonomous public health services and strong and autonomous veterinary services, in the respect of their specific expertises. The One Health initiatives that have followed the avian influenza crisis have seen the strengthening of laboratory capacity and the creation of joint medical/veterinary field teams. In Asia there are currently more active and ongoing human–animal health programmes than there have ever been. But a culture of cross-sectoral collaboration does not yet exist all along the chain. Fostering such a culture stretching from the field level to that of international organisations is the big challenge for successfully controlling either emerging or neglected zoonotic diseases.

35 Implementing 'One Health': follow-up from the Stone Mountain Meeting

Our specific goal: to develop sustainable intersectoral collaboration at international, regional national, and sub-national levels by identifying concrete opportunities for implementing 'One Health' strategies and recognizing key barriers and possible options for overcoming these barriers.

Malika Kachani

Following the Winnipeg consultation in 2009, a meeting was organized by the Centers for Disease Control and Prevention (CDC) in collaboration with FAO, OIE, WHO, to move the concept of One Health forward, and to define specific action steps. The meeting was hosted by the CDC, Atlanta, Georgia in May 2010 and was titled: *Operationalizing One Health: a policy perspective – taking stock and shaping an implementation roadmap.*

Fifty-four participants including specialists from national Ministries of Health and Agriculture, the European Commission, the UN, the World Bank, and other diverse institutions from the academic, policy and economic sectors contributed their expertise and experience to the discussion. The group reviewed progress to date in terms of leading practices related to One Health and identified key policy decisions and financial commitments necessary to support sustainability and expansion.

The participants were then asked to discuss a vision of how One Health should appear globally in the next 3–5 years. The following points were identified and agreed upon, for a common vision of One Health.

*A **culture change** that appreciates the importance of the connection between humans, animals and ecosystems.*
***An increased visibility** that recognizes the value added by operationalizing the One Health approach in preventing, detecting and controlling diseases that impact both humans and animals*
***Designated funding** to support interdisciplinary collaborative programs.*
***An improved coordination** that includes intersectoral collaboration in surveillance, communications, outbreak response and sample sharing*

Updates will be available at CDC One Health website: www.cdc.gov/onehealth

The participants were then asked to identify "critical enabling initiatives" that will further attainment of the 3–5 year goals, and that are feasible for completion over the next 18 months. Seven key activities were selected as fundamental to moving forward under the One Health agenda.

1. **Training**: develop and build skills, expertise and competencies through a One Health training curriculum which could be integrated into existing curricula.
2. **One Health Global Network**: establish a network as a vehicle for further global collaboration, advocacy and international support mobilization on One Health programmes and projects.
3. **Information Clearing House**: promote One Health advocacy through a centralized area where One Health success stories are gathered and made available to a wide-ranging audience.
4. **Needs Assessment**: develop country level self-assessment methods to identify programmatic areas that could benefit from a One Health approach and areas for targeting improvement.
5. **Capacity Building**: identify ways to leverage existing programs and capacity-building efforts in order to have a major impact at limited cost.
6. **Proof of Concept**: demonstrate that the use of One Health interventions leads to better cross-species health outcomes.
7. **Business Plan**: articulate the subject area of One Health more clearly and present it to policy-makers and donors at the global level.

36 Concluding statement: developing a roadmap for NZD prevention and control

The third international consultation on neglected zoonotic diseases

Over 100 people from all 6 WHO regions took part, meeting in the WHO executive boardroom in Geneva.

Those attending included individuals involved in active disease control programmes, research, policy-making and representatives of international organisations, NGOs as well as private sector companies who have funded NZD control work.

Together we produced the following statement.

The theme of the third international conference on NZDs – community-based interventions – considered the involvement and contribution of communities, often supported by government services and nongovernmental organizations, in the prevention and control of NZDs. A number of countries' successes in preventing and controlling NZDs were presented, including zoonotic trypanosomiasis (Uganda), rabies (China, Peru, the Philippines and Sierra Leone), fascioliasis (Peru and Viet Nam), echinococcosis (China), cysticercosis (Zambia), as well as issues of epidemic-prone NZDs such a Rift Valley fever (horn of Africa) and leptospirosis.

The Consultation issued a statement on the way forward to promote progress in combating NZDs

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The meeting was opened by Lorenzo Savioli, Director NTD and convened by François Meslin, Team Leader NZD.

THE CONSULTATION – ACKNOWLEDGING

1.1 The **considerable progress** that has been made since the first (2005) and second (2007) international conferences on NZDs (see Chapter 2: Five years on – taking stock).

1.2 The **high rates of both under-reporting and misdiagnosis** (clinical and laboratory-based) for NZDs in communities of poor and marginalized peoples and the substantial global burden these diseases impose on such communities especially in rural areas traditionally dependent on livestock for food, transport and draught power.

1.3 The **name "neglected zoonotic diseases", or "NZDs"** for this group of diseases emphasizes a new approach to dealing with them. This terminology acknowledges that these diseases are not well addressed and recognizes that three key requirements should be met for successful prevention and control of NZDs: (i) that consideration be given to both the needs of communities and their livestock and to companion animals affected by NZDs; (ii) that integrated approaches be available to cure, prevent and control disease at the human–animal interface; and (iii) that evidence-based advocacy be used to lever resources and commitment for control from the national and international community.

1.4 NZDs as a heterogeneous group of diseases which is best defined by the people and communities they mostly affect. As such, the list of NZDs is open-ended and depends on location; as well as endemic diseases, it may comprise epidemic-prone diseases such as leptospirosis, anthrax and Rift Valley fever.

1.5 The **One Health approach**, which addresses the actions required to alleviate the suffering and losses caused by NZDs at the human–animal interface. Control activities need to cover people, animals and their environments, and veterinary and human medical sectors need to work collectively to ensure successful control of NZDs. Where feasible, emphasis may be placed on controlling the animal reservoirs, and activities implemented in close collaboration with key sectors involved.

1.6 The **cost-effectiveness of controlling these diseases can reap a dual harvest** in saving human lives and securing livelihoods by protecting livestock and other domestic animals, which in turn contributes to alleviating poverty within affected communities.

1.7 The **feasibility of preventing, controlling and possibly eliminating those NZDs for which effective and workable proven solutions are available** (for example, dog-mediated human rabies and zoonotic trypanosomiasis) or that are within sight and for which control packages will be available or "tool ready" within 3–5 years of conducting implementation research (for example, cysticercosis, cystic echinococcosis and foodborne trematode infections).

THE CONSULTATION – CONSIDERING

2.1 The **universally low ranking of NZDs on national and international health agendas** despite their causing significant morbidity and mortality in the impoverished, mostly rural, livestock-dependent communities in which they exist. NZDs usually do not cross international borders and rarely affect international trade or travellers (unlike the new emerging zoonotic diseases such as avian influenza or SARS [severe acute respiratory syndrome]).

2.2 The **challenges of scaling up** implementation of control approaches using known strategies, testing the feasibility and cost-effectiveness of those strategies and in parallel prioritizing control of NZDs on the research agenda.

2.3 The **lack of investment in prevention and control activities and of applied research on NZDs from development aid and assistance programmes** within developed countries and from other sources of health funding at a time when expertise in developed and developing countries and funding for capacity strengthening in developing countries are waning. It is estimated that only 0.06% of international global assistance for health is devoted to the control of NZDs.

2.4 The lack of **veterinary public health (VPH) units** bridging the gap between departments of agriculture and health and that of competent practitioners in human health and veterinary services to serve the needs of communities in developing countries in addressing NZDs.

2.5 The need to identify and mobilize, in those countries most affected by NZDs, internal and external funding sources to **facilitate capacity-building for human and animal health staff** in all aspects of surveillance, prevention and control of NZDs.

THE CONSULTATION – RECOMMENDS THE CREATION OF A ROAD MAP TO PROMOTE PROGRESS IN COMBATING NZDS WHERE THEY ARE MOST PREVALENT THAT INVOLVES

3.1 Developing a **comprehensive methodology for measuring the burden** of disease that is attributable to zoonotic infections, providing the evidence-base required for needs assessment and advocacy; and assessing within this methodology the local, regional and global societal burdens of NZDs in financial and non-financial terms, thus defining the priority diseases for control on a local and regional basis.

3.2 Conducting further studies to determine **the costs of intervention strategies, cost-benefits and cost effectiveness**. In addition to measuring the direct and indirect medical costs and benefits, such studies should also consider the economic and societal impacts of animal disease as indirect contributors to poverty through their impact on nutrition, loss of meat and milk products, and the effects on livestock as capital assets.

3.3 Scaling-up interventions for control of NZDs in selected geographical and epidemiological settings using existing innovations and research outputs that are not being used for reasons of cost, lack of policy, intersectoral collaboration, commitment of relevant government structure and awareness, together with insufficient understanding of the high value offered by interventions that simultaneously target animals and reduce the disease burden in humans. Such activities should be based on the following four principles.

- **3.3.1 Strengthening or consolidating intersectoral collaboration, communication and interaction** using operational research and systems among key health, agricultural and environment sectors. This principle requires that guidelines on how to establish, structure and sustain VPH units be established at the national level. The contribution of VPH units to public health care should be clarified, while recognizing that the responsibilities of these units go beyond control of NZDs. Competent human and animal health services are a public good, and maintaining qualified VPH workers close to their communities should be considered an essential governmental responsibility. National intersectoral committees on zoonoses working under ministerial or a higher authority should be established or strengthened.
- **3.3.2 Controlling animal reservoirs** as the most effective approach to combating any animal disease, including most NZDs. This principle relies on a pool of VPH specialists working under a system of good governance. In many countries, such efforts should be carried out jointly by competent national VPH and public health services with the help and support of local and regional authorities applying the One Health approach.
- **3.3.3 Adopting or combining multi-disease and host approaches for selected NZDs in their animal reservoirs**. This principle relies on effective governmental services and the contribution of other stakeholders, principally communities affected by NZDs, and NGOs to improve animal and public health and, in parallel, ensuring environmental sanitation and providing the necessary health-care education and promotion to those communities involved.
- **3.3.4 Community-based approaches and interventions** developed to control specific diseases such as zoonotic trypanosomiasis, rabies and foodborne trematode infections should be evaluated for their applicability to other NZDs. Disease-specific and government-supported interventions may still represent a viable alternative under certain circumstances.

3.4 Initiating priority studies on short-term and longer-term packages of research to improve and sustain control of NZDs at scale. Stated priorities are grouped as disease-specific or intervention-specific (environmental health, intersectoral collaboration, epidemiological studies); these priorities relate to health education, health promotion and improved understanding of the environmental and social ecology of NZDs and their impact on both livestock production and local economies.

3.5 Strengthening advocacy within constituencies for NZDs to better inform all stakeholders, including funding agencies, about the societal burden of these diseases to create demand for control at all levels of society.

3.6.Providing resources to implement specialized training in all aspects of surveillance, prevention and control to serve national human health and national veterinary services in countries where NZDs represent a significant threat to local communities. Training in surveillance and laboratory diagnosis of NZDs is of paramount importance to improve reporting and assess their burden.

3.7.Providing affected countries with the skills to develop economically sustainable national control strategies, including economic evaluations integrating cross-sectoral costs and benefits.

3.8 Identifying priority NZDs in each WHO region and country by considering their impact on both human and animal health and the level of commitment for prevention and control from interested sectors. This approach will require budget lines from the relevant implementing ministries as well as national research commitments, stable policy and essential long-term national and international financing.

3.9 Requesting the WHO Secretariat, in collaboration with its partners and other stakeholders, to help define priorities and achievable goals and set targets and indicators to monitor the state of implementation of this road-map in 2 years' time. An inventory of the current and potential funding landscape for NZDs and an evaluation of their cumulative burden as well as a critical review of the outcomes of previous meetings would be useful.

3.10.Requesting pharmaceutical companies to broaden the scope of their collaboration and funding to include pharmaceutical products and the development of vaccines to be used in the context of interventions against NZDs.

3.11 Increasing awareness among the international funding community of the local, regional and global impacts of NZDs, and urging funding agencies to consider NZDs as an integral part of their portfolios in order to assist governments in supporting affected communities.

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Listening and discussing during the meeting .

Abbreviations

AE ..... alveolar echinococcosis
AIDS ..... acquired immunodeficiency syndrome
ASEAN ..... Association of South East Asian Nations
BMGF ..... Bill & Melinda Gates Foundation
CDC ..... Centers for Disease Control and Prevention (USA)
CE ..... cystic echinococcosis
CGIAR ..... Consultative Group on International Agricultural Research
CLTS ..... community-led total sanitation
COCTU ..... Coordinating Office for the Control of Trypanosomiasis (Uganda)
DALY ..... disability-adjusted life year (measure of health burden in humans)
DANIDA ..... Danish International Development Agency
DFID ..... Department for International Development (UK)
EU ..... European Union
FAO ..... Food and Agriculture Organization of the United Nations
FERG ..... Foodborne Disease Burden Epidemiology Reference Group (WHO)
FOS ..... Food Safety and Zoonoses (WHO)
GALVmed ..... Global Alliance for Livestock and Veterinary Medicines
GARC ..... Global Alliance for Rabies Control
GBD ..... global burden of disease
HAT ..... human African trypanosomiasis
HIV ..... human immunodeficiency virus`
HPED ..... highly pathogenic emerging or re-emerging diseases
HSE ..... Health Security and Environment (WHO)
HTM ..... HIV/AIDS, Tuberculosis, Malaria and Neglected Tropical Diseases (WHO)
ICONZ ..... Integrated Control of Neglected Zoonoses
IEC ..... information, education and communication
IKARE ..... IK Aid and Relief Enterprise Limited
ILRI ..... International Livestock Research Institute
LERG ..... Leptospirosis Burden Epidemiology Reference Group
MDG ..... millennium development goal
NCC ..... neurocysticercosis
NGO ..... non-governmental organization
NID ..... Neglected infectious diseases
NIH ..... National Institutes of Health
NIMPE ..... National Institute of Malariology, Parasitology and Entomology (Viet Nam)
NTD ..... neglected tropical diseases
NZDs ..... neglected zoonotic diseases

OD.....open defecation (see CLTS)
OIE.....World Organization for Animal Health
PAHO.....Pan American Health Organization
PEP.....post-exposure prophylaxis (rabies)
PVS.....performance of veterinary services
Rabnet.....Rabies network (WHO database on rabies)
RiU.....Research Into Use (DFID)
RVF.....Rift Valley fever
SAARC.....South Asian Association for Regional Cooperation
SADC.....Southern African Development Community
SOS.....Stamp out Sleeping Sickness (Uganda)
SEARG.....Southern and Eastern African Rabies Group
TB.....tuberculosis
TDR.....Special Programme for Research and Training in Tropical Diseases (UNDP/UNICEF/World Bank/WHO)
UNDP.....United Nations Development Programme
UNICEF.....United Nations Children's Fund
VLIR.....Vlaamse Interuniversitaire Raad (Belgium)
VPH.....veterinary public health
VS.....veterinary services
WAHID.....World Animal Health Information Database (OIE)
WHO.....World Health Organization
WRD.....World Rabies Day
YLD.....equivalent years (of healthy life) lost due to disability
YLL.....years of life lost

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Agenda and speakers

Day 1 – Tuesday 23 November 2010
Opening

Welcome
Lorenzo Savioli and François.X Meslin
Election of Chair
Samson Mukaratirwa
Nominations of rapporteurs
Eric Fèvre and Wendy Harrison
NZDs – diseases of poverty
David Molyneux
The double whammy
Alexandra Shaw

Successful community-based programmes

Zoonotic trypanosomiasis in Uganda
Anthony Mbonye
Human and dog rabies in the Philippines
Raffy Deray
Fasciolasis and rabies in Peru
Ana Maria Navarro
Hydatidosis in Xinjiang, China
Hao Wen
Cysticercosis in Zambia
Chummy Sikasunge
Fasciolasis in Viet Nam
Do Trung Dung
Animal health club and zoonoses centre in Sierra Leone
Roland Suluku
Community-led total sanitation (CLTS) for NZD prevention and control: a movement
Kamal Kar
Projection of a film on zoonotic trypanosomiasis control in communities of Uganda

The health and economic burden of endemic NZDs

Brucellosis and other bacterial diseases
Jakob Zinsstag
Parasitic zoonotic diseases (cysticercosis, echinococcosis/hydatidosis, trematodoses)
Paul Torgerson and Phil Craig
Rabies
Louis Nel
Where do NZDs stand in the context of the reassessment of the Global Burden of Diseases?
Colin Mathers

Day 2 – Wednesday 24 November 2010
The health and economic burden of epidemic-prone NZDs

RVF in the horn of Africa
Zuhair Hallaj
Leptospirosis
Bernadette Abela-Ridder
Rabies in China: a re-emerging disease
Yin Wenwu

The international context

Working at the human–animal health interface: the WHO strategy
Cathy Roth
NZDs and NTDs
Lorenzo Savioli
NZDs in TDR
Ayoade Oduola
Integrated control of neglected zoonoses in Africa: a EU supported project
Sue Welburn
EU supported research on neglected zoonotic diseases in FP7
Isabel Minguez-Tudela
Agriculture for Improved Nutrition and Health: the CGIAR Research Program
John McDermott
NZDs and the work of the OIE
Kate Glynn
NZDs and the work of the FAO
Katinka de Balogh

Using public–private partnerships to leverage funds and achieve impact

I-KARE activities for trypanosomiasis control in Uganda
Anne Rannaleet
GALVmed and zoonotic disease vaccine development
Johan Vanhemelrijck

One Health and NZD prevention and control

From the global response to influenzas towards One Health: initiatives of the European Commission on One Health and Neglected Zoonotic Diseases
Alain Vandersmissen
Implementing One Health: outcome and follow-up of the Stone Mountain meeting
Malika Kachani

From roadmap to global agenda

Discussions on the draft report and the way forward
Eric Fèvre and Wendy Harrison
Concluding comments
Samson Mukaratirwa
Closing
Dr Hiroshi Nakatani

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